

YOUR PERFECT RIDE The Tech-Lover's Guide to the Best New Cars

POPULAR science

**HOT TV
PROJECTORS**



**AND 48
OTHER
GREAT
GIZMOS**

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Saving a Scorched Earth

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**Spectacular
Technologies
to Halt Global
Warming**

**Deep Inside the Navy's
Secret Spy Sub**

+

**The Dangerous Folly of
Bunker-Busting Nukes**

+

The Banana Battles Extinction

Space Shades
Government scientists
propose launching
giant screens to scatter
incoming radiation.

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Scientists at the meeting had come up with some ideas for "geoengineering" Earth's climate. "We already are inadvertently changing the climate," says physicist Michael MacCracken, "so why not *adventently* try to counterbalance it?"

NOW YOU CO₂, NOW YOU DON'T, p. 52



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The Heat Is On

I WOKE THIS MORNING TO THE NEWS that a White House official and former oil-industry lobbyist has been moonlighting as an editor—repeatedly taking his red pen to government climate-report drafts to add doubt and ambiguity to otherwise strong declarations about the legitimacy of global warming and the central role played by humans burning fossil fuels.

This was a depressing revelation but, sorry to say, not a very surprising one. *New Yorker* writer Elizabeth Kolbert recently reported on a strategy document called “Winning the Global Warming Debate” that was prepared a couple years ago by influential Republican pollster Frank Luntz. In it, Luntz wrote that “the scientific debate is closing (against us) but not yet closed. . . . Voters believe that there is *no consensus* about global warming in the scientific community. Should the public come to believe that the scientific issues are settled, their views about global warming will change accordingly.”

So let’s be clear: There is consensus in the scientific community about global warming. The levels of carbon dioxide in the atmosphere are now higher than they’ve been in at least 420,000 years, and if nothing is done to reduce emissions, they will grow to twice pre-industrial levels by midcentury. There is a correlation between CO₂ levels and global temperature, and current projections are that average temperatures worldwide will rise between 2.5°F and 10°F by 2100. Is this debatable? Kolbert cited a recent study that looked at every peer-reviewed scientific paper on climate change published between 1993 and 2003. Of the more than 900 articles in the study, not one challenges the premise that human-influenced global warming is reality. And the national scientific academies of 11 countries, including the U.S., just released a statement saying, “It is likely that most of the warming in recent decades can be attributed to human activities. This warming has already led to changes in the Earth’s climate. . . . The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action.”

Fortunately, there are ways to address the problem, and they’re not limited to the mandatory emissions curbs that this country can’t seem to muster the social or political will to support. In this issue’s cover story [p. 52], Michael Behar investigates proposals for how we can engineer our way out of the climate-change spiral: build huge filter farms to pull carbon dioxide from the air, pump the greenhouse gas deep underground, even launch a giant “space mirror” to deflect some of the sun’s infrared rays.

The one thing we can’t do is use a pollster-defined notion of scientific debate as an excuse to do nothing.

MARK JANNOT

mark.jannot@time4.com



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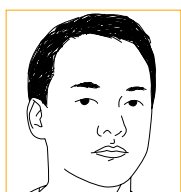
+



Writer **DAN KOEPFEL** [left] and photographer **JEFFREY WEISS** [right] traveled to the banana plantations of Honduras to report on the fungal blight that threatens the survival of the world's favorite fruit and on the scientists attempting to breed a replacement variety [page 60]. The two stayed in the Zona Americana, a gated suburb (complete with country club) that used to be home to the American banana elite—the managers of the once all-powerful United Fruit Company (which became Chiquita). "It was eerie," Koepfel says. "You never really forget the colonial history." Visiting the now locally owned non-profit research plantation, Weiss was most impressed with the energy displayed by botanist Juan Fernando Aguilar. "He's like the Indiana Jones of bananas," says Weiss, whose picture (taken by Koepfel) shows him perched on a ladder, shooting the banana pollinators in action. Both writer and photographer sampled many of the exotic banana varieties being developed. Their personal standout? The Prata Ana, a tart fruit with apple-like qualities that is beloved in Brazil.



+ This month in How 2.0, **NIGEL POWELL** teaches you how to set up an Internet radio station capable of beaming your own infallible taste in tunes to your friends [page 89]. It's only natural that the London-based Powell would write about the democratization of the "airwaves"; he fondly remembers pirate radio (broadcast from boats floating in international waters) in Britain. "I'm saddened by the decline of radio quality," he says. "Music doesn't deserve that."



+ Illustrating the U.S. Navy's newest spy submarine, the USS *Jimmy Carter* [page 81], sparked a certain déjà vu for artist **JASON LEE**—as a kid, he sketched a multitude of submarines (some being attacked by a giant squid, naturally). Lee, who attributes his fascination with subs to the '60s TV show *Voyage to the Bottom of the Sea*, says that his favorite novel tech feature on the *Jimmy Carter* is the airborne drone that is launched from a missile tube.



+ After considering all the audacious schemes scientists have proposed to lessen the effects of global warming [page 52], writer **MICHAEL BEHAR** was most intrigued by a huge orbiting screen designed to block solar radiation. "Of all the options—throwing iron into the oceans or pumping CO₂ underground—the sun screen has the least harmful environmental impact," explains Behar, whose last PopSci story was about technologies to mitigate natural disasters.



+ Automotive editor **ERIC ADAMS** spent several months testing what he calls "rolling technological showcases," such as the new Porsche Boxster and the Audi A6, for PopSci's Car Buyer's Guide [page 71]. Adams's love of cars began early in life—as a teenager, his bedroom decor included a Ferrari Testarossa poster. His favorite from the recent crop? The aggressive BMW M3. "The transmission is sensational," he says. "It's like you're in a videogame."

YOUR GUIDE TO THIS MONTH'S POPSCI

From "albedo" to "Zeus"

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PopSci for All Ages

I've been an avid reader of POPULAR SCIENCE since I was seven years old. I would get engrossed in all the techno toys, even if at that age I didn't really have a clue what I was reading. Now I'm a grown-up professional, and I'm stunned to see how POPSCI has grown with me. I had drifted away from the magazine in search of more practical publications, yet the new layout in What's New and the absolutely phenomenal How 2.0 section have won me back.

POPSCI empowers so many wannabe inventors and full-time geeks to envision, build, and create our dreams—without the expensive engineering degree.

Evan Paster
Cambridge, Mass.

Too Many Gadgets in My Science

I have subscribed to POPULAR SCIENCE for more than a decade. I have recently noticed that your magazine features less and less science and has become more like a multipage ad for the electronics industry. Your stories have become so abbreviated and shallow that I have to go to the Web to find any real information. If you are going to advertise science, you should provide science, not gadgets.

Timothy Reed
Dunedin, Fla.

"Master" Pieces

Fantastic article on Einstein ["Master of the Universe," June]. On the 100-year anniversary of special relativity, it's good to remind us all how good we have it thanks to one of the greatest thinkers in history. Whether or not 10 or more scientists would have discovered his theories eventually, Einstein discovered them all first himself.

One interesting footnote about how general relativity distorts space and, as you stated, "demands an active cosmos, one that's expanding or contracting, not the stationary universe that was favored pre-Einstein": Einstein himself refused to believe that the universe was expanding, even though his equations pointed toward that conclusion. He came up with the cosmological constant to explain the discrepancy. Then along came Edwin Hubble, who showed that the universe was expanding (leading to the big bang theory) after studying the redshift of galaxies using spectroscopes. Einstein clung to the static-universe theory until 1931, when he finally discarded the cosmological constant, calling it the "biggest blunder" of his life. It's amazing that he was right all along.

Tom Ryan
Bethesda, Md.

Einstein's accomplishments were truly astonishing. What he did was equal to putting a man on Mars and bringing him home while other men still believed the moon was made of cheese.

Joel Webster
Acworth, Ga.

Readers Get on Our Soapbox

Your article "Rewriting the Web's Rules" [Plugged In, Soapbox, June] mentioned how a Canadian Internet service provider (ISP) charges customers \$50 more to open ports to run an e-mail server because of bogus security risks. There actually are security risks, but not to the customer. The ISP is probably trying to deter spammers, and blocking e-mail server ports is a

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CORRECTION

• In the item "Future Fuel Fireplace" [The Goods, What's New, June], we incorrectly stated that the by-product of burning hydrogen is oxygen. It is in fact water vapor.



The Joy of Root Canals.

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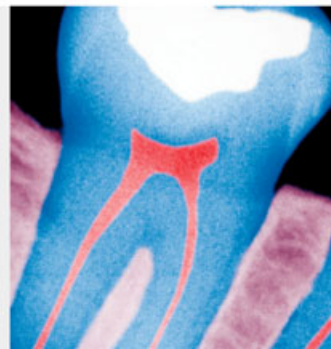
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great way to do this. If a spammer is trying to run an e-mail server, he will not want to spend any money. If someone wants to run a mail server for a legitimate reason, he might not mind paying the extra money.

A better solution to the spam problem might be to verify the customer's identity. Spammers would not want to do this, but customers would be more likely to do so than pay \$50.

Matt Vildzius
Roswell, Ga.

The article debunking Broken Heart syndrome ["Hype That Breaks Your Heart," MediaScope, Soapbox, June] was interesting, but it failed to address a very frequent phenomenon. It seems common for long-term spouses to die within a year or two of each other. Some assume that this is triggered by the stress of grief. I would love to see any scientific research about that.

Tracy Harrast
Athens, Ga.

Um, Thanks for Sharing!

Just wanted to let you know what I would create with the Vex Robotics Design System ["Do the Robot!" What's New, June]: My 12-year-old yellow lab is about at the end of his "bring me the morning paper" ability. So I would build a Paper Fetcher for the 6 a.m. trek to the end of the driveway, so the neighbors wouldn't have to see me in my underwear. Sorry for the visual.

Gene Belcher
Merritt Island, Fla.

FROM THE BLOGS

Last month, more than 650 Web logs linked to popsci.com. A sample:

I'm really tired of reading about the same old celebrity junk that permeates our American media. Maybe I'm just getting older, but I'd much rather read what the geniuses of the world are up to, instead of what flavor ice cream the pregnant Britney Spears craves. POPULAR SCIENCE gives you the low-down on all things scientific—but the jury is still out as to how many people would consider topics like Pacific plate drift "popular."

posted by Karen Pierson, *It's My Party*
it-smyparty.blogspot.com

AUGUST 2005



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YOUR GUIDE TO POPULAR SCIENCE ONLINE



THIS MONTH'S FEATURES



WEB
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EXTREME GRAVITY RACING

On August 18, major automakers will race their high-tech unpowered vehicles at Laguna Seca in California. Check out the fastest soapbox derby on the planet!



WELCOME TO BANANALAND

TAKE A VIRTUAL TOUR OF A HONDURAN BANANA PLANTATION AS PHOTOGRAPHER JEFFREY WEISS FOLLOWS THE FRUIT FROM THE FIELDS TO THE MARKET.

» WHAT'S NEW Watch the Extractor pull nails loose with ease.

» HEADLINES What would a nuclear bunker buster do to your city?

» HOW 2.0 Make your Internet radio-station dreams a reality.



AUTO TECH EXTRAVAGANZA

Which cars have the most outrageously powerful diesels? How can you keep your engine in top shape? Which wheels and tires should you buy—and which should you avoid? Also: reviews of hot new cars.

ENGINEERING EARTHQUAKES

HOW DARING SCIENTISTS PLAN TO CREATE SMALL QUAKES TO KEEP THE BIG ONE AT BAY



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GADGETS

Fistful of Browser

Replace your second computer with this portable tablet

» SINCE THE DAWN OF WIRELESS, the roving Google junkie has faced two options: a bulky wireless laptop or a Web-page-cropping PDA. This fall, however, Nokia (nokia.com) will introduce a palm-size Internet gadget that surfs Web pages in full, albeit scaled-down, glory, anywhere. Measuring three by six inches, the 770 connects to the Internet via Wi-Fi or a Bluetooth cellphone. Think of it as a \$350 replacement for that second PC (the one you leave on the coffee table to settle bets like who played Chet in *Weird Science**). Navigate the 4.13-inch 800-by-480-pixel touchscreen using a stylus, then use the PAN and ZOOM buttons to render the text readable even by granny standards. The 770 runs many of the applications you'd expect on a desktop PC—Web browser, e-mail client, RSS newsreader—as well as various media players, including Internet radio. That's because the 770 thinks it is a desktop PC: It's based on the same Debian version of Linux that powers millions of bigger computers. In keeping with Linux protocol, Nokia released the operating code to the open-source community, giving coding geeks free rein to develop additional applications. Wait until next year for the first new apps—most likely Instant Messenger and VoIP—or visit maemo.org to get the tools you need to modify your favorite programs or games to fit the tiny tablet. —PAUL WALLICH

[ACTUAL SIZE]



GET YOUR GOOGLE ON
The Nokia 770 makes
its debut this fall.

* Answer: Bill Paxton

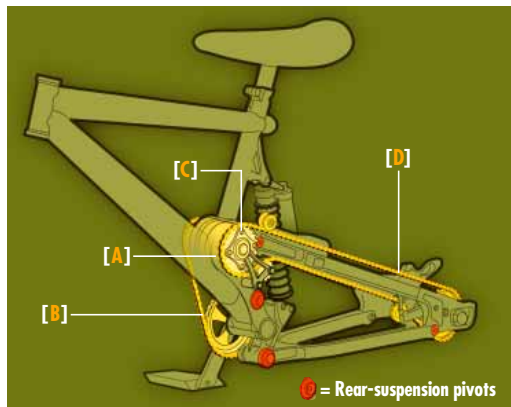
Control + Shift

A new internal transmission makes it easy to ride hard

» IN THE EVOLUTION OF RIDE-OVER-ANYTHING mountain bikes, the ever-vulnerable rear derailleur—that gangly parallelogram that shifts the chain up and down the rear cogs when it's not clogged with mud or bent by rocks—has been a glaring technical handicap. So GT (gtbicycles.com) got rid of it. With its \$5,000 IT-1, GT moves gear-changing duties to an unsullied haven *inside* the bike frame, by way of an eight-speed internal transmission. By using an internally geared rear hub and moving it to the center of the bike, GT created a more stable center of gravity and a stronger rear wheel. This also puts the drive chain in line with the suspension's primary pivot, essentially neutralizing the chain's effect on the suspension, so that when you pedal you're not fighting the movement of the rear end. Intended for a niche of "freeriders" who jump off 10-foot dirt cliffs and pedal over elevated, hand-built teeter-tottlers, the IT-1 is durable and heavy, at 45 pounds. If you can't handle it, just wait: This is merely the first mass-market iteration of what looks to be the future of dual-suspension designs. —STEPHEN REGENOLD



HOW IT WORKS At the heart of the IT-1's design is Shimano's new Nexus 8 hub [A]. As you pedal, the chain on the right side of the bike [B] turns the hub's axle, engaging its internal gears. (You shift from the handlebar as you normally would, lengthening or shortening a cable attached to the hub.) The cog on the left side of the axle [C] turns a second chain [D] that drives the rear wheel. The hub's internal gearing determines the speed of this chain.



● = Rear-suspension pivots



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Projecting a Better Image

The many faces of the new and much-improved front-projection TV

» FRONT PROJECTORS HAVE TRADITIONALLY BEEN bulky, complicated, expensive and of limited use because they truly shine only with the lights off. But brighter, higher-resolution display technologies have boosted performance (now you can watch with the lights on) and manufacturers have cut prices, so front projectors are enjoying a renaissance. Here are three that show off the latest trends. —JIM WILLCOX



HOME THEATER IN A PROJECTOR

Delivering home theater anywhere, **Optoma Technology's MovieTime** system [shown], HP's Instant Cinema Digital Projector and RadioShack's Cinego integrate a DVD player and speakers right into the unit. They aren't high-definition, and although the onboard speakers are fine, you can also use the audio outputs to connect to an A/V receiver for 5.1-channel surround sound.

PRICE \$1,500

RESOLUTION 854 x 480 pixels

MAX. SCREEN SIZE 335 inches

GET IT optoma.com

ULTIMATE-DEFINITION TV

Although 1080i (interlaced) is the highest-quality broadcast signal, next-gen high-definition DVD players and videogame systems will output an even better 1080p (progressive) signal. For around \$25,000, the Sony Qualia-004 and Fujitsu LPF-D711 take in and send out native 1080p. Or, for half the price, the **Samsung SP-H800BE** [shown], Hitachi PJTX100 and Toshiba TDP-MT800 will down-convert incoming 1080p material to 720p.

PRICE \$13,000

RESOLUTION 1,280 x 720 pixels

MAX. SCREEN SIZE 300 inches

GET IT samsung.com

BITSY BEAMER

Equally at home in briefcase or jacket pocket, **Mitsubishi's PocketProjector** [shown] is the first ultra-portable to reach the market (BenQ and Samsung have shown prototypes). All will owe their sub-two-pound body to their LED light source. Given their low light output, which requires a darkened room, these projectors are better paired with a laptop for instantaneous presentations than with a DVD player for watching movies.

PRICE \$700

RESOLUTION 800 x 600 pixels

MAX. SCREEN SIZE 40 inches

GET IT mitsubishi-presentations.com

JEFF HARRIS

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Mixing and mashing. Taking it on the road.
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Windows[®] xp

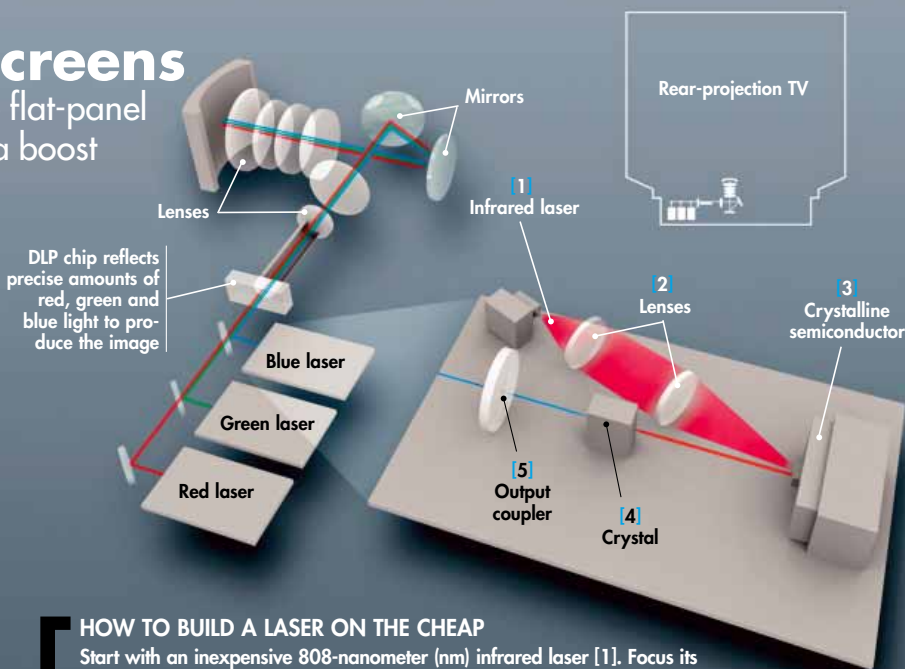
With a world of software and devices that run on Windows[®] XP,
the choice is yours. Go to windows.com and start anything you like.



Behind the Screens

Brighter, purer lights give flat-panel and rear-projection TVs a boost

» PRICEY PLASMAS aside, most types of big-screen TVs and projectors are lit by an incandescent bulb or fluorescent lamp, which lasts anywhere from 1,500 to 8,000 hours and isn't pure enough to reproduce the full spectrum of colors available in HDTV. By the time your bulb burns out, though, you might have better options: TVs illuminated by LEDs and lasers can last 10,000 to 15,000 hours and create a wider color gamut. Engineers are working on boosting LED light into a beam bright enough to illuminate ever-larger flat screens. As for lasers, whose concentrated beam is bright enough to light up an 80-plus-inch screen, the trick is making them cost-efficient (a 52-inch laser TV made with today's components would run \$300,000). Coherent's new laser system [coherentinc.com; see illustration] reduces cost by minimizing the number of parts needed to build green and blue lasers, which could lead to laser-based TVs in two or three years. There would be a small premium in price and a huge payoff in picture quality. —JIM WILLCOX



HOW TO BUILD A LASER ON THE CHEAP

Start with an inexpensive 808-nanometer (nm) infrared laser [1]. Focus its light through a pair of lenses [2] onto a crystalline semiconductor [3] that re-emits light at either 920nm (when making blue) or 1060nm (when making green). Halve the resulting wavelength by sending it through a second crystal [4] to produce visible blue (460nm) or visible green (530nm) laser light as it exits the output coupler [5].

	PROS	CONS	AVAILABLE
LASER 	Very bright, wide color gamut, easily powers large screen sizes	High initial cost, still in prototype stage, manufacturability uncertain	2008
LED 	Wide color gamut, long life, energy-efficient	Relatively expensive, low brightness, heat-dissipation issues	Limited use, 2005
BULB/LAMP 	Low cost, mature technology, bright white light	Short life span, high power use, sensitive to vibration	Now



Toshiba's TheaterWide 62HM195 (\$3,800) uses a mechanical aperture to limit backlight as necessary.

TVs Get Night Vision

Turning out the light can help you see better in the dark

» IT TAKES LOTS OF LIGHT to deliver bright, crisp images on your rear-projection TV, but that same light leaks through to the screen during dark, *Perfect Storm*-style gloomy scenes, hindering detail. To darken the blacks, a growing number of LCD and DLP rear-projection-TV manufacturers are turning to mechanical apertures that can limit the amount of light that reaches the screen. HP, Toshiba and Sony, among others, are using a dynamic iris, which automatically narrows like a camera's aperture to reduce the amount of stray light. Mitsubishi's approach, on the other hand, works like a shutter, quickly opening and closing after light leaves the DLP chip. The controls continuously monitor video, limiting the light output by as much as 75 percent during dark scenes. The resulting contrast ratios—the difference between the blackest blacks and the whitest whites—can be increased fourfold to about 5,000:1, or slightly better than plasma and direct-view LCD TVs. —J.W.



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Easy does it with these smart-jawed tools

» **HAND TOOLS FOR TURNING NUTS** and extracting nails can be a man's best friend—or foe. These innovative new grippers are designed to deliver unparalleled leverage and versatility, making it easier than ever to squeeze into tight spots to dislodge a rusted nut or extract a headless nail. Now there's no excuse not to DIY. —ALAN J. HEAVENS

PROBLEM

Salvaging antique molding littered with bent screws and headless nails

SOLUTION

The Extractor

Sick of struggling to remove nails that hadn't been smacked square on the head, veteran carpenter Jeff Wagner invented the Extractor: 11-inch-long pliers with unique parallel jaws that prevent shearing a nail as you pull it. Grip the nail, and rock the tool onto the bulbous lower jaw. The harder you press on the upper handle, the harder the jaws clench the nail. \$23 » nailextractor.com



The Bionic Wrench clamps down to the size of 16 different wrenches.

PROBLEM

Your jalopy requires a different repair at every spotlight

SOLUTION

The Bionic Wrench

The eight-inch-long Bionic Wrench adjusts easily to fit any bolt or nut from $\frac{1}{8}$ to $\frac{3}{4}$ of an inch (or 11 to 20 millimeters). Squeeze the handle, and six piston-like steel levers close in to grab the nut, equally distributing force across the flats so that you don't strip it. \$29

» loggerheadtools.com



PROBLEM

Getting the right angle to remove a rusted bolt lodged in a tight space

SOLUTION

Craftsman Locking Flex Ratcheting Wrench

Flexible wrenches are great in cramped spaces, but if the tool doesn't lock into place, you can't generate the necessary torque. The box-end of Craftsman's new chrome ratcheting wrenches pivots 90 degrees in either direction from the handle, and a unique lever allows you to lock it in any of nine positions along that 180-degree arc. The seven-piece standard set ranges from $\frac{1}{8}$ to $\frac{3}{4}$ inches. The seven-piece metric set has wrenches of 8, 10, 12, 13, 15, 17 and 19 millimeters. \$125 » craftsman.com

» **POPSCI ON THE WEB** See the Extractor in action at popsci.com/extractor.

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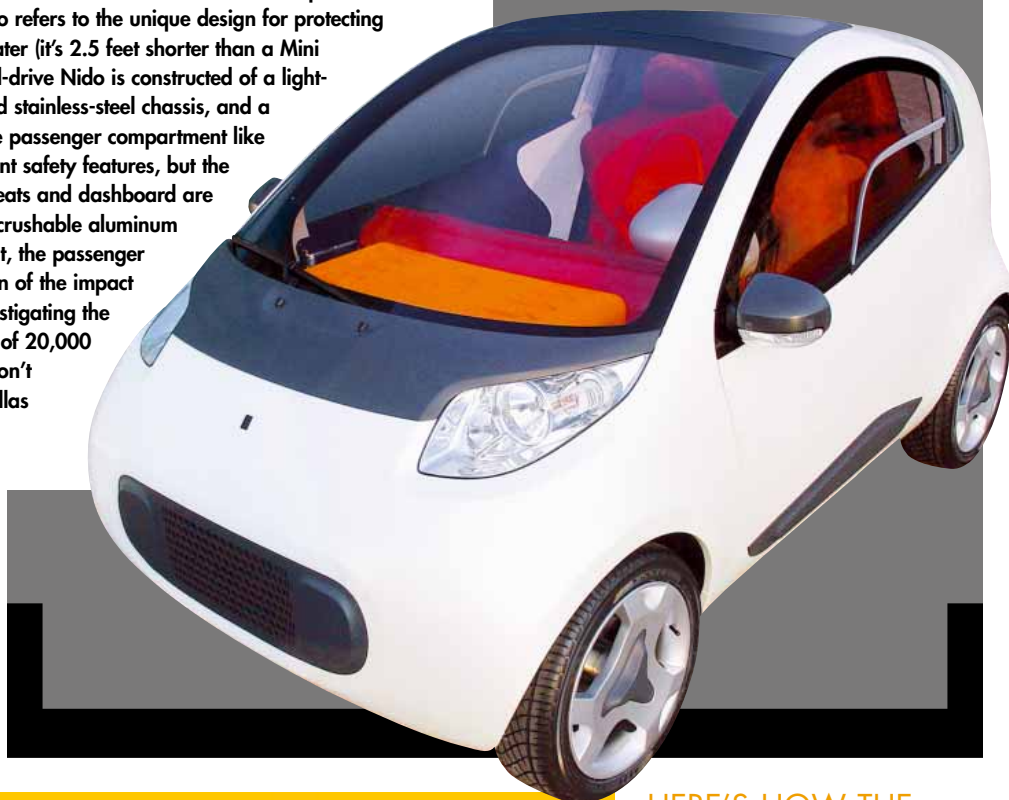
Italian Hardbody

A corrugated steel chassis puts subcompact safety first

» PINT-SIZE CARS ARE THE PRACTICAL OPTION in European cities, whose streets seem to be designed for wheelbarrows, but they come up short on safety. Keenly aware of this dilemma, Milan-based automotive designer Pininfarina has reconsidered subcompact safety from the inside out with its Nido concept car. Named after the Italian word for “nest,” Nido refers to the unique design for protecting passengers of this diminutive two-seater (it’s 2.5 feet shorter than a Mini Cooper). The rear-engine, rear-wheel-drive Nido is constructed of a light-weight yet extremely rigid corrugated stainless-steel chassis, and a robust steel-tube frame surrounds the passenger compartment like a Nascar roll cage. These are excellent safety features, but the innovation is in the namesake: The seats and dashboard are suspended within the cage between crushable aluminum absorbers. In the event of an accident, the passenger “sled” moves in the opposite direction of the impact to dissipate shock. Pininfarina is investigating the feasibility of producing a limited run of 20,000 Nidos over the next five years, but don’t expect them Stateside, where Truckzillas rule the land. —MATTHEW PHENIX

SMALL CAR, BIG DEPARTURE

The Nido is a new direction for Pininfarina. The Italian engineering firm is best known for designing supercars like Ferraris and Maseratis.



THE SPECS

LENGTH	9.5 ft.
WIDTH	5.5 ft.
HEIGHT	5 ft.
WHEELBASE	6.8 ft.
ENGINE	None (yet)

HERE'S HOW THE CUTIE CRUMBLES

During a head-on collision, two foam-filled steel pyramids [1] in the front end absorb some of the crash energy and then further divert impact forces away from the Nido’s driver and passenger along the corrugated steel floorboards and chassis [2]. The occupants themselves ride atop an internal “sled” [3] that slides up to 13.8 inches forward independent of the chassis as the crash occurs, compressing a cluster of variable-density aluminum honeycomb absorbers [4] to more gently dissipate the shock. Similar absorbers behind the sled [5] soak up crash energy from rear-end impacts.



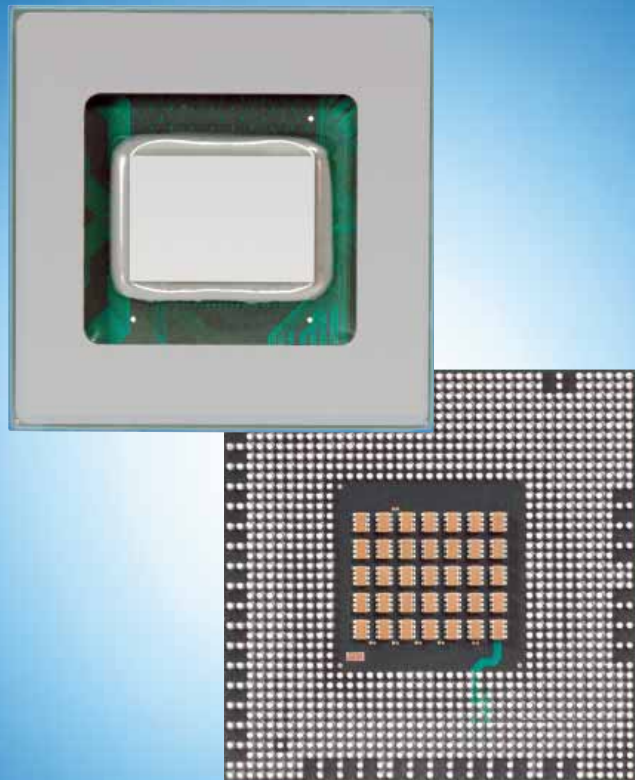
ILLUSTRATIONS: STEPHEN ROUNTREE; PHOTOGRAPH: COURTESY PININFARINA



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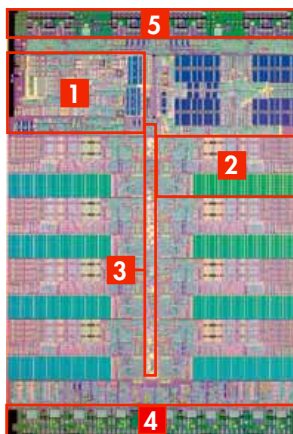
CHIP SANDWICH
A 1.7-square-inch plastic casing houses the Cell processor [inner gray rectangle on the casing's front side, at top].

Need for Speed

Meet the multitasking chip at the center of PlayStation 3

» VIDEOGAMES HAVE NEVER looked more hauntingly realistic, yet many don't seem to have the artificial-intelligence oomph to act realistic. (You can practically smell the city burning in *Half-Life 2*, but shouldn't the guards flinch when you blow the head off one of their squad mates?) Now a powerful new chip will add brains to the games' beauty. Developed by IBM, Sony and Toshiba, the much-ballyhooed 3.2-gigahertz Cell processor is packed with nearly 235 million transistors and nine onboard processors that can blast simultaneously through multiple calculation-intensive tasks, such as physics-simulation algorithms. Parallel processing is the latest performance-enhancing approach: Instead of upping gigahertz ratings, which are approaching their practical limits, chipmakers are combining more than one processing core on a single chip. AMD and Intel recently released dual-core processors that can handle four calculations at the same time. The Cell chip's unprecedented nine cores can perform up to 18 tasks at once. The Cell's first assignment will be crunching numbers for PlayStation 3 when the game console arrives next spring, but that's just one of its many potential applications. IBM plans to incorporate the technology in its next-gen systems, and next year Toshiba will launch an HDTV set that uses it to decode high-definition digital-television signals. For now, though, we're waiting on PlayStation 3, eager to blow more things up real good. —STEVE MORGENSTERN

PLAYSTATION 3'S CHIP (UNDRESSED)



1 The **Power Processor Element (PPE)**, an updated version of the PowerPC processors in Apple computers, runs the chip's operating system, divvying up calculation chores among the eight Synergistic Processing Elements (SPEs).



2 The **SPEs** are the math whizzes of the Cell, programmable to handle a variety of calculations, from artificial-intelligence algorithms to audio encoding.



5 The **Rambus XDR DRAM** accesses memory at a blazing 25.6 gigabytes — the equivalent of four full-movie DVDs — per second to keep the chip constantly fed with data.

4 The **Rambus FlexIO** moves data from the processor to external chips (including, in the case of PlayStation 3, Nvidia's graphics processor) at up to 76.8 gigabytes a second, 10 times as fast as any other chip.



3 The **Element Interconnect Bus (EIB)** connects the PPE and the SPEs.



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THEMSELVES **BY JOE BROWN**



Night Rider

Pedalite » Inside this illuminated bike pedal is a geared generator that translates your cranking into volts of electricity to power its three LED lights. They'll flash for up to 12 minutes after you stop pedaling. **\$92 a pair**
» pedalite.com

Forget Your Keys— for Good

Mykey » This radio-frequency-ID door lock has all its bases covered. Forget your chip? Use the keypad to enter your code. Electricity out? A pair of contacts lets you temporarily power it with a nine-volt battery. **Price not set** » thegadgethome.com



Control Carpal Tunnel

Saitek Pro Gamer Command Pad
» Assign each of the 11 keys up to three functions to condense your control center. Toggle between them quickly using the three side-row buttons while the adjustable wrist support keeps your hand in the optimum position. **\$40** » saitekusa.com



Home (Theater) Away from Home

ZVOX Mini Audio System » The 13x9.5x3.3-inch, three-speaker cabinet pumps out 35 watts of virtual surround sound and will plug into the wall or your car's cigarette lighter. For an extra \$50, pick up the rechargeable lithium-ion battery pack. **\$200** » zvoxaudio.com



Clot on the Spot

Seal-On Blotters
» Forget the dots of toilet paper when you cut yourself shaving. These dissolving strips contain oxidized cellulose, a clotting aid derived from cotton. It forms a gel-like coating over minor wounds. **\$3.30 for a 10-pack** » seal-on.com

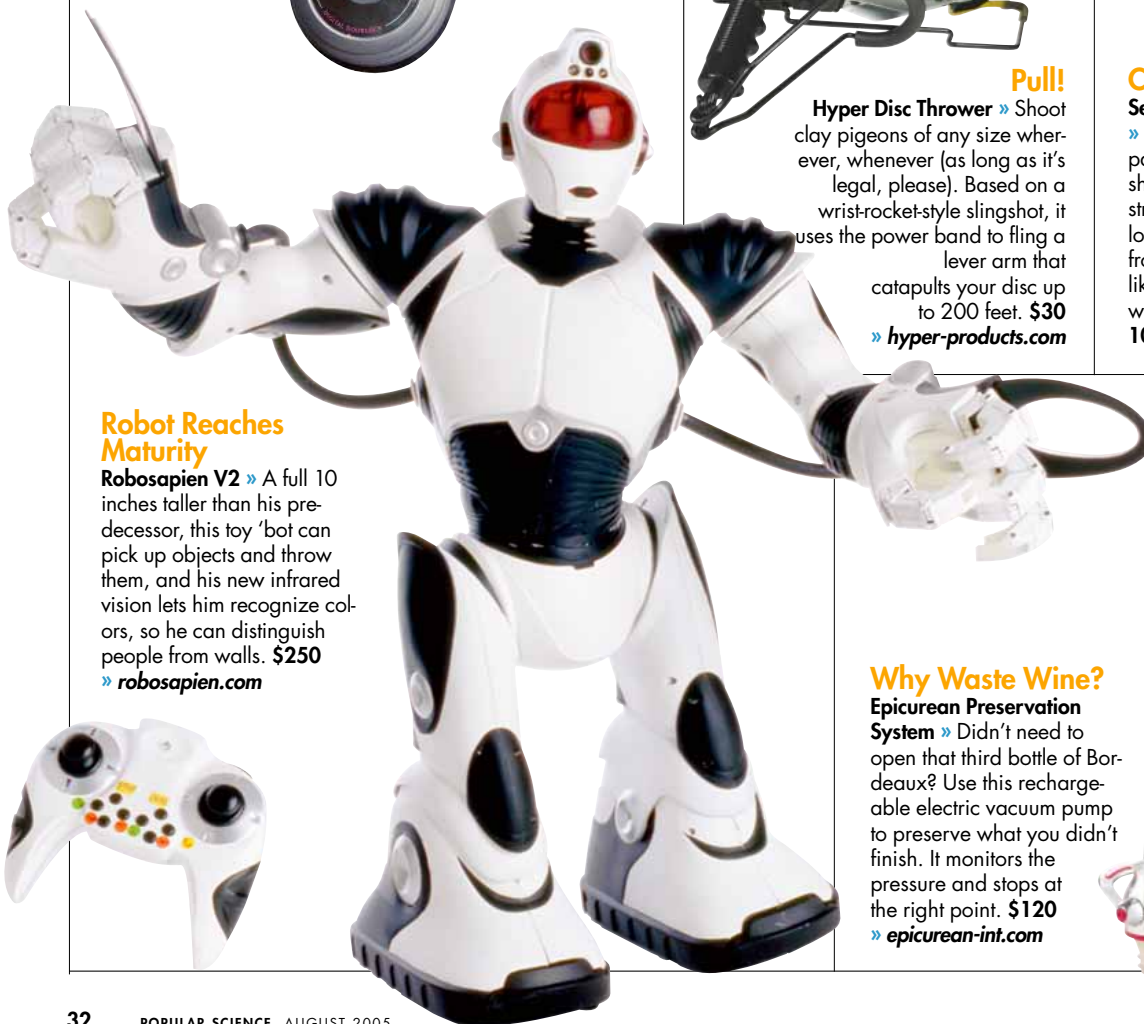


Pull!

Hyper Disc Thrower » Shoot clay pigeons of any size whenever, whenever (as long as it's legal, please). Based on a wrist-rocket-style slingshot, it uses the power band to fling a lever arm that catapults your disc up to 200 feet. **\$30**
» hyper-products.com

Robot Reaches Maturity

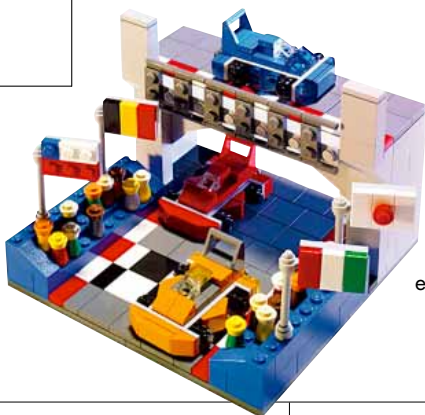
Robosapien V2 » A full 10 inches taller than his predecessor, this toy 'bot can pick up objects and throw them, and his new infrared vision lets him recognize colors, so he can distinguish people from walls. **\$250**
» robosapien.com



Why Waste Wine?

Epicurean Preservation System » Didn't need to open that third bottle of Bordeaux? Use this rechargeable electric vacuum pump to preserve what you didn't finish. It monitors the pressure and stops at the right point. **\$120**
» epicurean-int.com





Block Party

Lego Factory

» Using Lego's new digital design suite, you can build your own project online and have Lego send you a kit with the parts you need to make it (plus a few extras). Try replicating this racetrack scene.

Starting at \$10
» legofactory.com



Sensitive to Your Needs

Mio269 Mobile Navigation System » A GPS that works equally well whether you're driving or walking. It zooms in when you're moving slowly, metering out directions in proportion to speed, giving you time to react. 2.5-gig hard drive.
\$800 » miogps.com

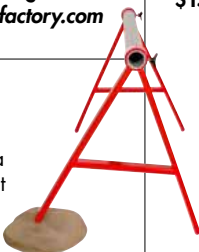
Cut Your Own Record

Vestax VRX-2000 Vinyl Recorder » A cutting stylus incises vinyl blanks, letting you record your cassette tapes, CDs, digital files or other audio sources onto a record. It'll play them back, too.
\$15,000 » vestax.com



Self-Leveling Sawhorse

Stud Horse » Using a 2.5-inch PVC conduit instead of a two-by-six board for the center section lets this sawhorse adjust to uneven terrain. Loosen the gib screw, and the legs rotate around the pipe so that they sit steady. **\$100**
» theultimatesawhorse.com



Size Matters

Samsung Digimax Pro 815 » This camera has everything: a 28-420-millimeter lens that does wide angle to telephoto, an industry-leading 15x optical zoom and a 3.5-inch LCD. Its battery will last 500 shots. Eight megapixels. **\$850** » samsungcamerausa.com

Easy-Off Rachmaninoff

Spracket » Wire the wall mount to your stereo, and bolt the other half of the bracket to your speaker; put them together, and the contacts conduct the electricity that makes the music. **\$50 a set**
» cewlconnections.com



Shake Your Funny-Maker

WarioWare: Twisted!

» The first game cartridge with a gyroscope in it uses your movements to control more than 200 mini games. For example, wiggle your Game Boy to navigate a maze. **\$35**
» warioware.biz/twisted

Location, Location, Location

Gizmondo » Finally launching in the U.S. this month, here's a portable game system that—with its integrated GPS and 1.3-megapixel digital camera—can use your coordinates for scavenger-hunt-style games. **\$230** » gizmondo.com



Fights Boredom and Bacteria

i-Bead 600 MP3 Player
» The coating of ionic silver nanoparticles kills 99.9 percent of *E. coli* and staph bacteria that alight on its casing while you rock to your digital audio files. Up to two gigs flash memory. **Price not set** » ibead.co.kr



Craft Works

Dremel Dual Temp Glue Gun » Burn-scarred craft makers everywhere will appreciate this innovation: Because the glue-melting tip is insulated by a silicone coating, even when it's on, it's cool to the touch. **\$25** » dremel.com

Step into the Light

Swiss Army Alchemist » Four LEDs around the crown of the zip-off hood light your way as you jog on those rainy nights. Gets its juice from two AAAs sealed in a watertight battery pack. **\$85** » swissarmy.com



Concealing the Evidence

StealthSurfer II USB Key » This flash drive actively masks your IP address, redirects your Web-surfing history to its memory as you go, and automatically fills out e-commerce order forms with your personal information. Up to one gig. **\$100 for 128 megs** » stealthsurfer.com



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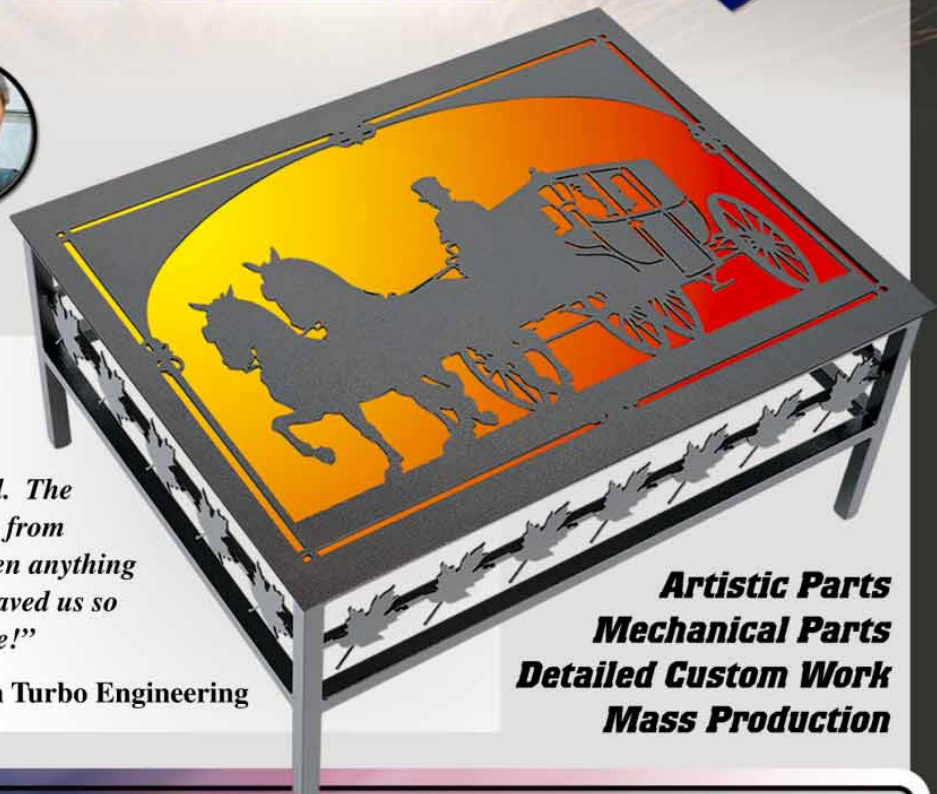


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-Jim, Custom Turbo Engineering



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PIECE BY PIECE Fixation on puzzles is a hallmark of autism, a brain disease that strikes 1 in every 166 kids. New studies may explain why.

[MEDICAL DISCOVERIES]

Cracking the Autism Puzzle

Far-reaching new studies home in on elusive autism genes and the environmental factors that may trigger them

A PAIR OF TWINS IS BORN, AND BOTH INFANTS BEGIN TO DEVELOP normally. By their first birthday, however, the male sibling has begun to diverge from his sister, showing less eye contact and affection. He often wears a spaced-out expression and fixates on certain puzzles and patterns. By age three, his mounting symptoms lead to a diagnosis that has become disturbingly routine in recent years: autism.

What causes the disease, which now strikes 1 in every 166 children, and why does it affect four times as many boys as girls? Geneticists at the University of California at Los Angeles are closing in on the answers. This spring they announced that they had pinned down the likely location of an autism gene on chromosome 17. The evidence was found only in families with autistic males, indicating a hereditary basis for the disease's gender bias. Reporting the discovery in the *American Journal of Human Genetics*, the scientists will next try to find

the actual gene among the 50 or so clustered nearby, a painstaking process that could take another year. "If we're lucky," says co-author Rita Cantor, a professor of genetics at the university's David Geffen School of Medicine, "we'll be able to explain 10 percent of autism."

To complicate matters, researchers believe that the gene is probably just one of dozens linked to autism, many of which may trigger the disease only if a genetic predisposition is activated by some external factor.

So where does environment come into the picture? Although we have decoded our genome, our "envirome"—everything that influences a person *after* conception, from parenting to pollution—remains a fragmented riddle. To decipher the envirome's role in the disease, William Eaton, a psychiatrist at the Bloomberg School of Public Health at Johns Hopkins University,

[MEDICAL DISCOVERIES] CONTINUED

recently helped to conduct a large-scale study involving nearly 700 Danish children. Some intriguing correlations emerged. Scouring for trends among a host of parameters such as birth weight and socioeconomic status, scientists discovered an increased prevalence of autism both in children with a family history of schizophrenia and in those whose births involved complications such as premature or breech delivery.

Casting an even wider net than the Danish survey, researchers at the University of California at Davis are conducting a study called CHARGE (Childhood Autism Risks from Genetics and the Environment) to scrutinize everything from

The only other disease that rivals autism in complexity is cancer, says Pessah.

genes to mercury exposure. "The hope is that we'll find patterns," says toxicologist Isaac Pessah, who is director of the school's Center for Children's Environmental Health. "We're not looking for the magic bullet that causes autism."

Churning through reams of data, the study has uncovered its first pattern: that certain proteins, metabolites and immune-system components in blood samples from autistic children differ sharply from normal ones. Announced in May at the International Meeting for Autism Research in Boston, the discovery could lead to the first-ever blood test for autism in newborns, allowing treatment to begin long before outward symptoms typically occur.

If autism is indeed caused by the complex interaction of genetic and external factors, Pessah believes that eliminating the environmental problems would be easier in the short term than the awesome biomolecular challenge of finding and altering the offending DNA. "I don't think there's going to be genetic intervention in my lifetime," he says. There is only one other human disease, Pessah points out, that rivals autism in complexity. It's called cancer. —JOSHUA TOMPKINS

[WEAPONS]

Bombs Away?

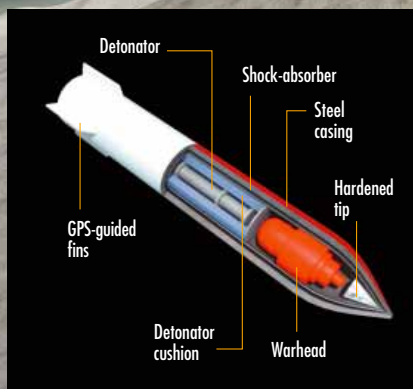
Scientists cast doubt over the Pentagon's plan to build a new nuclear bunker buster

ACCORDING TO THE U.S. DEPARTMENT OF DEFENSE, HUNDREDS OF underground bunkers in enemy territories serve as weapons silos, command centers and safe havens for rogue leaders. Drilled several hundred feet or deeper into the ground, many of the hideouts are far beyond the reach of conventional weapons. The Pentagon's solution: Build a super-slim bomb called a Robust Nuclear Earth Penetrator (RNEP) capable of piercing 20 feet of solid rock and unleashing shock waves on par with a magnitude-7 earthquake.

This fall Congress will decide whether to approve \$8.5 million to complete a feasibility study of the RNEP. But a recent report from the National Academy of Sciences, a government-funded scientific advisory group, threatens to strike the weapon dead. Issued in May, the 150-page report concludes that the "bunker buster" would fare better than conventional weapons but may leave many targets unscathed and could result in more than one million civilian casualties.

On all counts, an earth-tunneling bomb is a tall order. The sole nuclear bunker buster in the U.S. arsenal, the 300-kiloton B61, can't penetrate rock. According to the NAS, to strike deeply buried targets in rocky terrain would require a one-megaton bomb or stronger—one that is up to 80 times as potent as the Hiroshima bomb. What's more, the RNEP would need to burrow thousands of feet into the ground to contain fallout from the blast.

Here, one scenario envisioned by the NAS. —RENA MARIE PACELLA



THE B83 MAKEOVER

The Pentagon plans to convert its B83 thermonuclear gravity bomb into a nuclear bunker buster in large part because the Nuclear Non-Proliferation Treaty of 1970 discourages the building of new nukes. With a 1.2-megaton yield, the B83 is our nation's largest warhead. It would be retrofitted with a sharpened nose for spearing rock and a shock-mitigating layer to protect it on impact.

ILLUSTRATIONS: KRIS HOLLAND, MAFIC STUDIOS, INC.

B-2 BOMBER

NUKING A BUNKER, IN FOUR STEPS

1 A B-2 bomber flying at an altitude of 40,000 feet drops a modified B83 nuclear weapon carrying a 1.2-megaton warhead. It travels 2,000 feet per second toward its ground target.

2 Assuming the soil is composed of granite, the nuke will penetrate to a depth of 20 feet within 100 milliseconds. Radar sensors on the warhead detonate the nuke once it has plowed to its target depth, releasing the energy of more than a million tons of TNT.

3 The blast creates a 1,200-foot-wide crater and sends a shock wave traveling 1,116 feet per second through the ground. The wave will destroy everything down to 1,000 feet. Any bunkers deeper than that could survive the blast.

4 The National Academy of Sciences estimates that the explosion will shoot some 300,000 tons of radioactive debris up to 15 miles into the air. The total number of casualties will vary but could exceed one million, depending on weather, wind velocity and the blast's proximity to towns and cities.

AN ILL WIND BLOWS

Where and how far radioactive debris travels depends on weather and wind conditions. On an average day in North Korea, radiation from a 1.2-megaton blast could reach as far as Tokyo.



FOUR-DAY RADIATION EXPOSURES

YELLOW Lethal to 50 percent of population
ORANGE Induces radiation sickness
RED Equivalent to a full-body x-ray

Source: Federation of American Scientists

1,000 feet

Honda's comm

Honda has been a leader in the area of automotive safety research and design. And, as a part of our continuing safety efforts, we plan to lead the industry into the future. By the end of 2006, our commitment to "Safety for Everyone" will equip virtually every Honda and Acura model*, regardless of size or price, with the following safety features as standard equipment:

⚡ **Front side airbags with Occupant Position Detection System (OPDS)** – Standard on 82% of our models by the end of 2004 and on 100% of our models by the end of 2006.

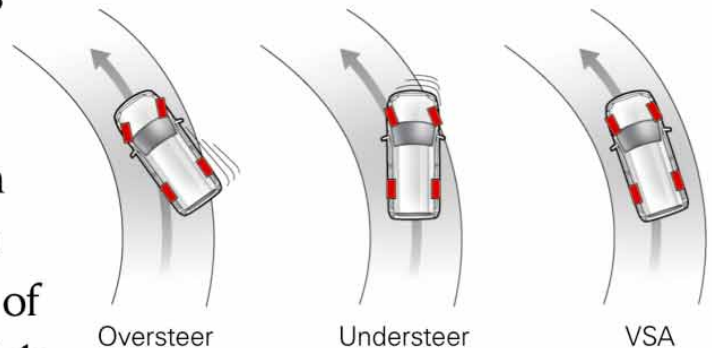
⚡ **Side curtain airbags for every row** – By the end of 2004, will be



Side curtain airbags

standard on 64% of our product line and standard on 100% of our entire line by the end of '06.

⚡ **Anti-lock braking system (ABS)** – Standard equipment on 88% of all our models by the end of 2004. 100% of our models will feature it as standard equipment by the end of '06.



⚡ **Vehicle Stability Assist (VSA®) and rollover sensor** (for the side curtain airbag deployment) – Will be standard on 84% of all our light-duty trucks, including SUVs and minivans, by the end of 2004 and on 100% of our light-duty trucks by the end of 2006.

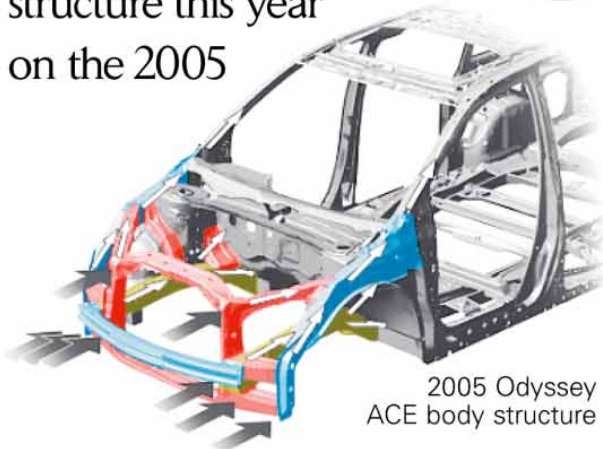
itment to safety.

🚧 **Pedestrian Safety** – In an effort to protect people outside of our cars, Honda will continue to pioneer the use of external features designed to help reduce pedestrian injuries. By the end of 2004, 96% of our entire product line will be equipped with pedestrian-protection features; 100% will have this equipment by the end of '06.

Honda pedestrian test dummy



🚧 **Advanced Compatibility Engineering™ (ACE™)** – Additionally, Honda will introduce the ACE body structure this year on the 2005



2005 Odyssey
ACE body structure

Honda Odyssey and Acura RL.

The ACE design provides enhanced driver and passenger protection and also helps minimize damage to other vehicles in an accident. ACE will be standard on every Honda and Acura within the next seven years.

Honda has embarked upon an ambitious and innovative safety program. The goals and plans for this program extend well beyond our current technology and the year 2006. Because this endeavor is not simply a commitment to building safer vehicles, it's a commitment to "Safety for Everyone."

HONDA

The power of dreams.™

[THE ANNOTATED MACHINE]

A User-Friendly Drone

Punch in a few directions on a PC, and this two-foot chopper will lift off, shoot video, and land—no pilot or remote required

» LEARNING TO FLY A HELICOPTER TAKES hundreds of hours, and even then few pilots feel safe maneuvering one over enemy terrain or forest fires. Yet missions such as these are precisely what choppers are good for, where on-the-fly surveillance may mean the difference between life and death. It doesn't take a genius to appreciate the potential benefits of a miniature copter, mounted with a remote-control camera, that flies itself.

To build one, though, takes real ingenuity, as choppers are not inherently aerodynamic. Although dozens of contractors are building customized autonomous copters for the military, Israeli manufacturer Steadicopter is the first company to build one cheaply, in a design readily adaptable to myriad governmental and civilian applications, on a virtually unlimited range of

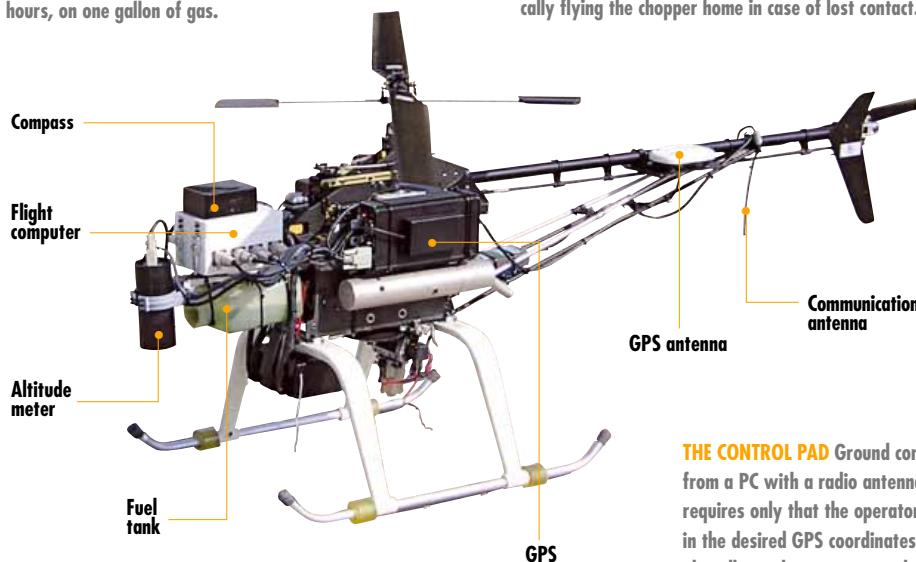
flight platforms. The \$150,000 standard model weighs just 18 pounds. It can take off from the top of a truck and requires no flight skills, says company spokesman Amir Rochman. The operator simply inputs GPS coordinates on a laptop, and the chopper uses gyros, accelerometers, and barometric and ultrasonic altitude instruments to hold a steady course, sending back video as it flies.

Beyond firefighting and defense, the copter, which will be available by December, is expected to be popular with news agencies, provided that the Federal Aviation Administration approves it. (Currently the FAA imposes tough restrictions on all unmanned air vehicles, especially those with exposed rotor blades.) In Australia, though, where flight regulations are less strict, Steadicopter stands ready for takeoff. —JONATHON KEATS

[INSIDE THE ROBO-COPTER]

THE COPTER The 18-pound, two-foot-tall dual-engine helicopter will take off on a five-square-yard patch of flat ground and fly at several hundred feet for up to two hours, on one gallon of gas.

THE PILOT All flight parameters are controlled by an autonomous robotic system, which keeps the copter stable even in heavy winds and navigates it to any specified location up to three miles from the base, automatically flying the chopper home in case of lost contact.



THE CAMERAS The copter is mounted with video and night-vision thermal cameras, directly controlled from, and providing instant feedback to, the base PC.

THE CONTROL PAD Ground control from a PC with a radio antenna requires only that the operator type in the desired GPS coordinates. It also allows the operator to change the route or speed in-flight, based on the chopper's video feed or digital maps of the region.

[THE POPSCI POLL]

BASED ON 3,028 VOTES
POSTED TO POPSCI.COM

LAST MONTH'S QUESTION:

HYBRID CARS:

5%
ALREADY HAVE ONE

68%
MIGHT BUY ONE

27%
I ♥ GAS GUZZLERS

THIS MONTH'S QUESTION:

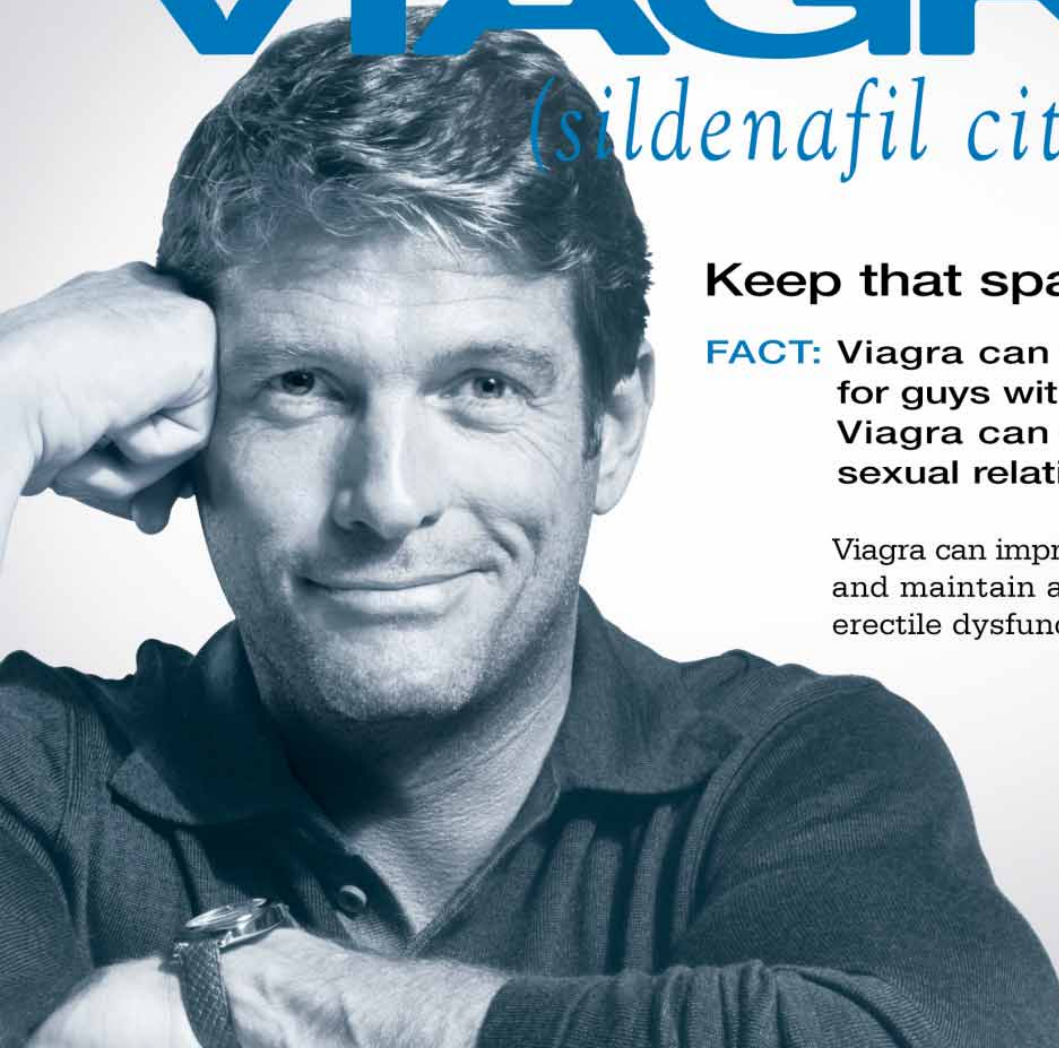
SHOULD SCIENTISTS CREATE ARTIFICIAL WOMBS TO HELP INFERTILE COUPLES BEAR CHILDREN?

YES NO

VOTE AT POPSCI.COM

VIAGRA[®]

(sildenafil citrate) tablets



Keep that spark alive.

FACT: Viagra can improve erections for guys with ED. Studies show Viagra can also improve their sexual relationship satisfaction.

Viagra can improve the ability to achieve and maintain an erection for guys with erectile dysfunction. **Ask your doctor if VIAGRA is right for you.**

To learn more, visit viagra.com or call 1-888-4VIAGRA

VIAGRA is prescribed to treat erectile dysfunction. We know that no medicine is for everyone. If you use nitrate drugs, often used for chest pain (known as angina), don't take VIAGRA. Taking these drugs together could cause your blood pressure to drop to an unsafe level.

The most common side effects of VIAGRA are headache, facial flushing, and upset stomach. Less common are bluish or blurred vision, or being sensitive to light. These may occur for a brief time. Remember to protect yourself and your partner from sexually transmitted diseases.

Talk with your doctor first. Make sure you are healthy enough to have sex. If you have chest pain, nausea, or other discomforts during sex, seek medical help right away. Although erections lasting for more than four hours may occur rarely with all ED treatments in this drug class, it is important to seek immediate medical attention. Erections lasting longer than six hours can result in long-term loss of potency.

VIAGRA is covered under most Managed Care Plans.

Please see our patient summary of information for VIAGRA (25 mg, 50 mg, 100 mg) tablets on the following page.



U.S. Pharmaceuticals

VG242505C © 2005 Pfizer Inc. All rights reserved.

VIAGRA®

(sildenafil citrate) tablets

This summary contains important information about VIAGRA®. It is not meant to take the place of your doctor's instructions. Read this information carefully before you start taking VIAGRA. Ask your doctor or pharmacist if you do not understand any of this information or if you want to know more about VIAGRA.

This medicine can help many men when it is used as prescribed by their doctors. However, VIAGRA is not for everyone. It is intended for use only by men who have a condition called erectile dysfunction. **VIAGRA must never be used by men who are taking medicines that contain nitrates of any kind, at any time. This includes nitroglycerin. If you take VIAGRA with any nitrate medicine your blood pressure could suddenly drop to an unsafe or life threatening level.**

• What Is VIAGRA?

VIAGRA is a pill used to treat erectile dysfunction (impotence) in men. It can help many men who have erectile dysfunction get and keep an erection when they become sexually excited (stimulated).

You will not get an erection just by taking this medicine. VIAGRA helps a man with erectile dysfunction get an erection only when he is sexually excited.

• How Sex Affects the Body

When a man is sexually excited, the penis rapidly fills with more blood than usual. The penis then expands and hardens. This is called an erection. After the man is done having sex, this extra blood flows out of the penis back into the body. The erection goes away. If an erection lasts for a long time (more than 6 hours), it can permanently damage your penis. You should call a doctor immediately if you ever have a prolonged erection that lasts more than 4 hours.

Some conditions and medicines interfere with this natural erection process. The penis cannot fill with enough blood. The man cannot have an erection. This is called erectile dysfunction if it becomes a frequent problem.

During sex, your heart works harder. Therefore sexual activity may not be advisable for people who have heart problems. Before you start any treatment for erectile dysfunction, ask your doctor if your heart is healthy enough to handle the extra strain of having sex. If you have chest pains, dizziness or nausea during sex, stop having sex and immediately tell your doctor you have had this problem.

• How VIAGRA Works

VIAGRA enables many men with erectile dysfunction to respond to sexual stimulation. When a man is sexually excited, VIAGRA helps the penis fill with enough blood to cause an erection. After sex is over, the erection goes away.

• VIAGRA Is Not for Everyone

As noted above (*How Sex Affects the Body*), ask your doctor if your heart is healthy enough for sexual activity.

If you take any medicines that contain nitrates – either regularly or as needed – you should never take VIAGRA. If you take VIAGRA with any nitrate medicine or recreational drug containing nitrates, your blood pressure could suddenly drop to an unsafe level. You could get dizzy, faint, or even have a heart attack or stroke. Nitrates are found in many prescription medicines that are used to treat angina (chest pain due to heart disease) such as:

- nitroglycerin (sprays, ointments, skin patches or pastes, and tablets that are swallowed or dissolved in the mouth)
- isosorbide mononitrate and isosorbide dinitrate (tablets that are swallowed, chewed, or dissolved in the mouth)

Nitrates are also found in recreational drugs such as amyl nitrate or nitrite ("poppers"). If you are not sure if any of your medicines contain nitrates, or if you do not understand what nitrates are, ask your doctor or pharmacist.

VIAGRA is only for patients with erectile dysfunction. VIAGRA is not for newborns, children, or women. Do not let anyone else take your VIAGRA. VIAGRA must be used only under a doctor's supervision.

• What VIAGRA Does Not Do

- VIAGRA does not cure erectile dysfunction. It is a treatment for erectile dysfunction.
- VIAGRA does not protect you or your partner from getting sexually transmitted diseases, including HIV — the virus that causes AIDS.
- VIAGRA is not a hormone or an aphrodisiac.

• What To Tell Your Doctor Before You Begin VIAGRA

Only your doctor can decide if VIAGRA is right for you. VIAGRA can cause mild, temporary lowering of your blood pressure. You will need to have a thorough medical exam to diagnose your erectile dysfunction and to find out if you can safely take VIAGRA alone or with your other medicines. Your doctor should determine if your heart is healthy enough to handle the extra strain of having sex.

Be sure to tell your doctor if you:

- have ever had any heart problems (e.g., angina, chest pain, heart failure, irregular heart beats, heart attack or narrowing of the aortic valve)
- have ever had a stroke
- have low or high blood pressure
- have a rare inherited eye disease called retinitis pigmentosa
- have ever had any kidney problems
- have ever had any liver problems
- have ever had any blood problems, including sickle cell anemia or leukemia
- are allergic to sildenafil or any of the other ingredients of VIAGRA tablets
- have a deformed penis, Peyronie's disease, or ever had an erection that lasted more than 4 hours
- have stomach ulcers or any types of bleeding problems
- are taking any other medicines

• VIAGRA and Other Medicines

Some medicines can change the way VIAGRA works. Tell your doctor about **any medicines** you are taking. Do not start or stop taking any medicines before checking with your doctor or pharmacist. This includes prescription and nonprescription medicines or remedies:

- Remember, VIAGRA should never be used with medicines that contain nitrates (see *VIAGRA Is Not for Everyone*).
- If you are taking alpha-blocker therapy for the treatment of high blood pressure or prostate problems, you should not take a dose of greater than 25 mg of VIAGRA at the same time (within 4 hours) as you take your dose of alpha-blocker.
- If you are taking a protease inhibitor, your dose may be adjusted (please see *Finding the Right Dose for You*).
- VIAGRA should not be used with any other medical treatments that cause erections. These treatments include pills, medicines that are injected or inserted into the penis, implants or vacuum pumps.

• Finding the Right Dose for You

VIAGRA comes in different doses (25 mg, 50 mg and 100 mg). If you do not get the results you expect, talk with your doctor. You and your doctor can determine the dose that works best for you.

- Do not take more VIAGRA than your doctor prescribes.
- If you think you need a larger dose of VIAGRA, check with your doctor.
- VIAGRA should not be taken more than once a day.

If you are older than age 65, or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg) of VIAGRA. If you are taking protease inhibitors, such as for the treatment of HIV, your doctor may recommend a 25 mg dose and may limit you to a maximum single dose of 25 mg of VIAGRA in a 48 hour period. If you are taking alpha-blocker therapy, you should not take a dose of greater than 25 mg of VIAGRA at the same time (within 4 hours) as your dose of alpha-blocker.

• How To Take VIAGRA

Take VIAGRA about one hour before you plan to have sex. Beginning in about 30 minutes and for up to 4 hours, VIAGRA can help you get an erection if you are sexually excited. If you take VIAGRA after a high-fat meal (such as a cheeseburger and french fries), the medicine may take a little longer to start working. VIAGRA can help you get an erection when you are sexually excited. You will not get an erection just by taking the pill.

• Possible Side Effects

Like all medicines, VIAGRA can cause some side effects. These effects are usually mild to moderate and usually don't last longer than a few hours. Some of these side effects are more likely to occur with higher doses. The most common side effects of VIAGRA are headache, flushing of the face, and upset stomach. Less common side effects that may occur are temporary changes in color vision (such as trouble telling the difference between blue and green objects or having a blue color tinge to them), eyes being more sensitive to light, or blurred vision.

In rare instances, men have reported an erection that lasts many hours. You should call a doctor immediately if you ever have an erection that lasts more than 4 hours. If not treated right away, permanent damage to your penis could occur (see *How Sex Affects the Body*).

Heart attack, stroke, irregular heart beats, and death have been reported rarely in men taking VIAGRA. Most, but not all, of these men had heart problems before taking this medicine. It is not possible to determine whether these events were directly related to VIAGRA.

VIAGRA may cause other side effects besides those listed on this sheet. If you want more information or develop any side effects or symptoms you are concerned about, call your doctor.

• Accidental Overdose

In case of accidental overdose, call your doctor right away.

• Storing VIAGRA

Keep VIAGRA out of the reach of children. Keep VIAGRA in its original container. Store at 25°C (77°F); excursions permitted to 15-30°C (59-86°F) [see USP Controlled Room Temperature].

• For More Information on VIAGRA

VIAGRA is a prescription medicine used to treat erectile dysfunction. Only your doctor can decide if it is right for you. This sheet is only a summary. If you have any questions or want more information about VIAGRA, talk with your doctor or pharmacist, visit www.viagra.com, or call 1-888-4VIAGRA.



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September 2002

SHRINKAGE DEPT.

Research updates on
the quest to make really tiny things



The world's most finely resolved image

FOCUSING ON THE SMALL STUFF

Rejoice, all detail-oriented readers:

Using just a thin slip of silver foil, researchers at the University of California at Berkeley have crafted a "superlens" that resolves features as small as one hundredth the size of a red blood cell. The invention could pave the way for ultrasensitive medical scanners, faster PCs, and DVDs capable of storing the entire contents of the Library of Congress.

Glass lenses form images by capturing and bending light waves as they bounce off objects. But they can't see evanescent waves, a type of light that decays before it reaches the glass. As a result, even today's strongest lenses lose focus on details smaller than 400 nanometers.

The Berkeley group has discovered a way to detect and amplify evanescent waves using silver. When the waves strike a thin piece of silver, they stir up electrons on the metal's surface, creating a kind of antenna that strengthens and focuses the light into a point. To demonstrate this phenomenon, the researchers sandwiched a piece of silver foil (the superlens) between a chrome plate etched with the word "nano" and an ultraviolet-light-sensitive polymer coating. When the scientists shined UV light onto the plate, the superlens resolved details of the inscription as small as 60 nanometers.

The next challenge: to detect and magnify evanescent waves from a greater distance. Only then could the lens scan a blood sample for disease or etch high-density DVDs. —JR MINKEL

[ELECTRONICS]

Television Watches Back

A new device uses TV antennas to find you where GPS can't

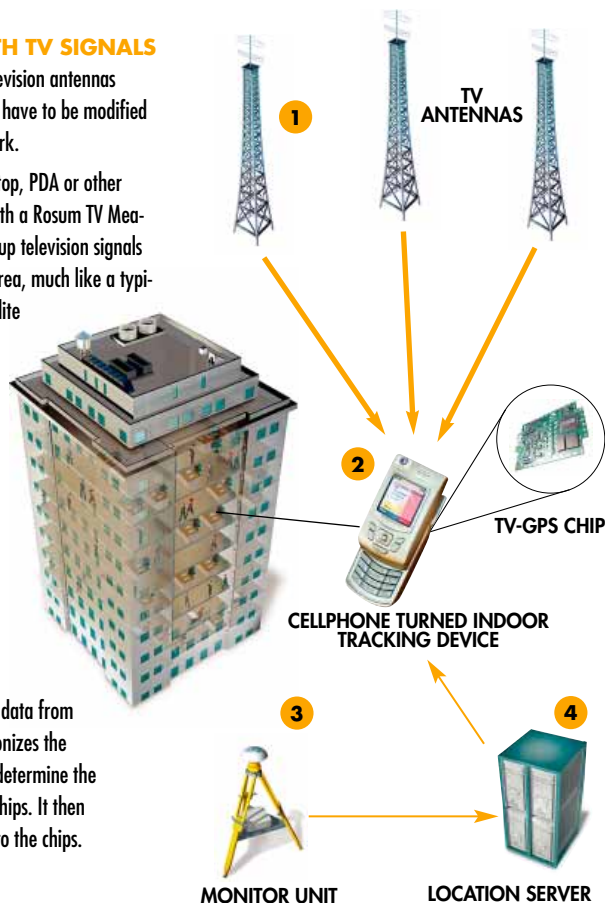
» TODAY'S GLOBAL POSITIONING SYSTEM IS GREAT FOR TRACKING TANKS IN THE desert, but turn on your Garmin in New York City or inside virtually any building, and you'll be staring at satellite static—GPS doesn't perform well indoors or in urban canyons. Now a new technology is poised to pick up where GPS satellite signals cut out.

Developed by Rosum Corporation in Redwood City, California, TV-GPS, as the system is known, triangulates positions using television signals that are 2,000 times as strong as GPS satellite transmissions. With nearly 2,800 TV antennas concentrated mainly in U.S. metropolitan areas, where GPS coverage is weakest, TV-GPS has a ready-made infrastructure. The result is a 12,500-kilowatt locating system (GPS is about 500 watts) that can track Rosum's patented chipset indoors, outdoors, in taxis, subways or almost any dark city corner.

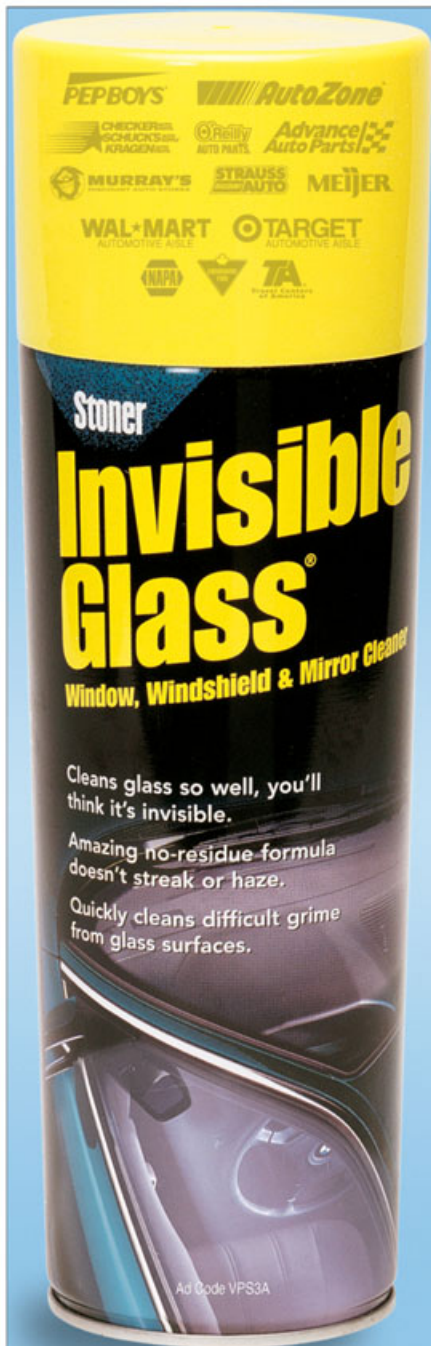
So far, Rosum is working with GPS giant Trimble in Sunnyvale, California, to get its chip in semi trucks by early 2006 for fleet tracking. After that, Rosum will roll out TV-GPS applications to help the police track parolees and for 911 tracking in the next generation of portable voice-over-Internet devices. But the technology's biggest break may come from Uncle Sam. Last December, President Bush put out a call for a backup locating system in case the aging GPS system, first deployed in 1978, fails. Rosum is betting its system fits the bill. —JASON DALEY

TRIANGULATING WITH TV SIGNALS

1. There are roughly 2,800 television antennas around the U.S. These won't have to be modified in any way for TV-GPS to work.
2. A GPS device, cellphone, laptop, PDA or other portable gadget equipped with a Rosum TV Measurement Module chip picks up television signals being broadcast in a given area, much like a typical GPS device picks up satellite signals. From these signals it triangulates its latitude and longitude.
3. Unlike the GPS system, TV stations don't have a common synchronized clock, which is necessary to give an accurate position. So the system uses a computerized monitor unit to track and measure TV signals.
4. The location server crunches data from the monitor unit and synchronizes the broadcast-channel clocks to determine the position of Rosum's TV-GPS chips. It then transmits that location data to the chips.



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[PHARMACEUTICALS]

The Straight Dope on Cannabis-Inspired Meds

While the medical marijuana debate rages on, drug companies race to leverage the power of pot

» LAST SPRING CANADA BECAME THE first and only country to approve a drug called Sativex to treat the chronic pain endured by most of the 2.5 million people with multiple sclerosis. The announcement caused, ahem, quite a buzz. Sativex is a whole-plant extract of high-grade *Cannabis sativa*, a.k.a. marijuana, and is the first prescription drug to contain all 60-plus of the plant's cannabinoids, those compounds that include the psychoactive chemical THC. Although the drug packs a pain-numbing punch, its mouth-spray formulation slows its release into the body, thus diminishing those consciousness-altering

side effects associated with smoking marijuana.

Despite a U.S. Supreme Court decision in June to uphold the ban on medical marijuana, drug companies are not discouraged. In fact, Sativex is just one of nearly two dozen new pharmaceutical compounds inspired by the herb. Last year the Society for Neuroscience conference featured almost 200 papers on cannabinoids; a decade ago there were exactly zero. And 22 pharmaceutical companies, including giants Pfizer and GlaxoSmith-Kline, helped fund last year's meeting of the International Cannabinoid Research Society. In 1992 not a single drug company attended,

according to executive director Richard Musty. "Now," he says, "they're showing up and madly taking notes."

The newfound interest stems from a flurry of discoveries in the early 1990s that showed that the body is littered with cannabinoid receptors. In fact, we have more of them in the brain than most other types, which may explain why they regulate such a vast array of functions—appetite, pain, memory, mood. Luckily for us, such multitasking paves the way for drugs to treat everything from obesity and migraines to cancer and Parkinson's disease. Below, a small sampling of the goods. —JILL DAVIS

THE DRUGS	THE PROMISE	HOW IT WORKS	STATUS	THE UPSHOT
 SATIVEX GW PHARMACEUTICALS	Relieves the severe nerve pain experienced by some 80 percent of people with multiple sclerosis	Think liquid pot. Once spritzed under the tongue, the drug is slowly ferried to pain-blocking cannabinoid receptors in the brain	Approval in Canada is based on a four-week trial in the U.K.; U.S. trials are slated to begin by the end of the year	Sativex is less addictive than other painkillers. Trouble is, it works best in conjunction with them
 ACOMPLIA SANOFI-AVENTIS	Lowers triglycerides, raises HDL ("good" cholesterol), and improves insulin resistance in obese and overweight patients	Tames appetite by blocking cannabinoid receptors in the brain and in some fat cells, which helps the body to better metabolize sugar	This April, Sanofi-Aventis filed for approval in both the U.S. and Europe. Acomplia could be ready by 2006	A true breakthrough. It's the first drug to treat factors that lead to heart disease by targeting the body's cannabinoid system
 CANNABINOR PHARMOS CORPORATION	Relieves acute postoperative pain without the serious side effects associated with heavy-duty opiates such as morphine	Currently injected intravenously, it stimulates cannabinoid receptors in the immune system that help reduce inflammation	Safety trials in Europe are slated for this year. Pharmos hopes to develop an oral dose by the drug's release date in 2008	Cannabinor would be the first drug to treat post-op pain by targeting the cannabinoid system, but so far it has been tested in just 12 animal studies

HEADLINE FROM THE FUTURE

MICHAEL WYSESSION



2034 LUBRICATING MICROBES PREVENT MEGA-QUAKE

Scientists put into play an audacious plan to lube up the Juan de Fuca tectonic plate and stop a major earthquake in the Pacific Northwest. Using 3-D models of Earth's mantle, they target areas of critical strain buildup and then drill 15-mile-deep boreholes near those regions. The next step: Inject millions of lab-bred gelatinous microbes into the boreholes. Genetically engineered to thrive in pulverized rock at temperatures exceeding 600°F, the bacteria-like "extremophiles" seep into the ground, proliferate, and spread across the plate boundary, forming a jellylike ooze that greases the fault and allows the plates to slide more smoothly. The result is minor, relatively harmless tremors.

Michael Wyssession is a geophysicist at Washington University in St. Louis. He is helping to devise the first-ever 3-D map of Earth's entire mantle in order to better identify regions of intense strain accumulation.

08.10.05 **ROVERS GET COMPANY** NASA IS SLATED TO LAUNCH THE *MARS RECONNAISSANCE ORBITER*, THE MOST POWERFUL SPACECRAFT YET TO VENTURE TO THE RED PLANET ■

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PLUGGED IN

YOUR PERSONAL-TECH
ADVOCATE

BY CORY DOCTOROW



Saving Your Set

THE ISSUE: Studio execs want to control what your TV can do. Here's the inside story of how they were stopped . . . this time

MAY 6, 2005, SHOULD BE A HOLIDAY. IT'S WHEN A U.S. CIRCUIT COURT OF APPEALS saved your TV by stopping the "broadcast flag," an innovation-killing regulation Hollywood had essentially blackmailed the FCC into enacting.

In 2002 the major studios threatened to withhold shows and movies for broadcast on digital TV (DTV) unless the government gave them control over the design of DTV devices. Then they formed the Broadcast Protection Discussion Group (BPDG)—a cabal of tech companies, broadcasters and Hollywood studios—to work on the broadcast flag, a single bit that was to be embedded in every DTV signal and function like an on-off switch. Flag-compliant devices, such as TVs and receivers, would have to look for the flag and respond to it by limiting the output and recording abilities to

those approved by Hollywood. Manufacturing a device that didn't comply with the flag would be illegal.

The studios' argument was that DTV was more appealing to online file-sharers because of the high quality of the picture. But until average high-speed bandwidth multiplies several times, anyone who wants to put a recorded TV show on the Internet has to compress the video anyway, so the quality ends up being no better than an analog recording. What's more, anyone could still capture a DTV signal from the analog ports on a receiver and import it into their PC. The broadcast flag was a futile solution to an imagined problem.

The broadcast flag was a futile solution to an imagined problem.

When my Electronic Frontier Foundation colleagues and I said as much at that first BPDG meeting three years ago, they dismissed us as cranks. Andy Setos, the Fox exec who thought up the flag, told me that he just wanted to create "a well-mannered marketplace."

Many tech companies, including Sony, Toshiba and Apple, showed up and sold out from the start, eager to trade the freedom to innovate for a spot on the short list of approved DTV technology suppliers. Recalcitrant companies got a talking-to. During one meeting, the studio reps hauled Microsoft's contingent out of the room for an hours-long arm-twisting session on the issue of how PCs would handle DTV.

Initially, the studios had convinced former Louisiana representative Billy Tauzin to sponsor a bill introducing whatever restrictions they came up with. But Tauzin wouldn't touch the mishmash of monopoly-making pronouncements they ultimately devised. Instead, former South Carolina senator Ernest "Fritz" Hollings sent former FCC

GRAB LIFE BY THE HORNS



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*Based on R. L. Polk & Co. vehicles in operation statistics CYE 1984-2003.

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chairman Michael Powell a love note telling him that he didn't need a law. In Hollings's view, the FCC already had the jurisdiction to enact the flag. (It was later revealed that the note may not have been written by the senator's office but by the Motion Picture Association of America.)

Ignoring opposition, the FCC scheduled the flag to take effect on July 1, 2005. So in February 2004, the EFF joined the American Library Association and other groups in asking the Washington, D.C.,

3 MORE THINGS TICKING CORY OFF THIS MONTH

1

► ACADEMIC SCAN BAN

University presses say that Google's plan to scan their books and create searchable, full-text indexes of their content is infringement and are trying to shut the project down.

► COPYRIGHT CRAZIES

The official who runs the U.S. Copyright Office is suggesting to Congress that copyright infringement is used to fund terrorism, citing only rumors.

2

3

► INVASIVE ACTS

If the latest iteration of the Patriot Act passes, the FBI will be able to get your health records, e-mail, and banking details without a judge's approval.

► Read more at popsci.com/soapbox.

Circuit Court of Appeals to rule that the FCC's jurisdiction covered only the transmission and reception of signals, not what happens after they're received.

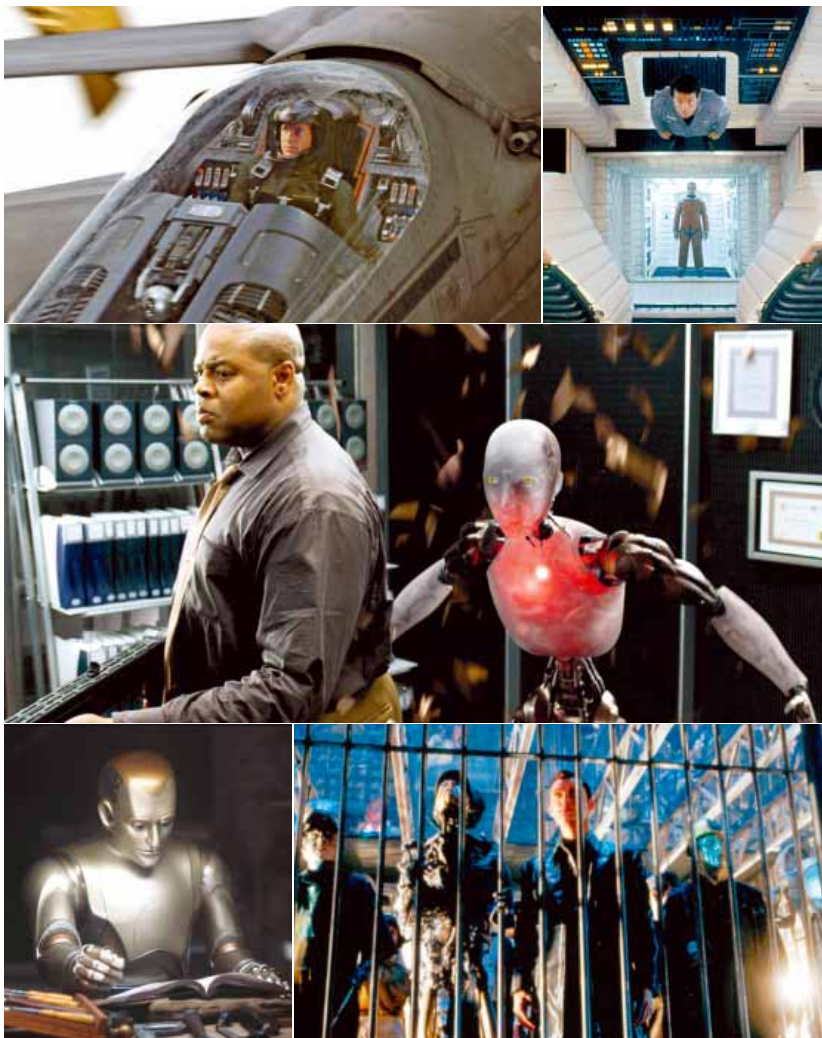
And on May 6, the court agreed, saying, "In the seven decades of its existence, the FCC has never before asserted such sweeping authority. In our view, nothing has changed to give the FCC the authority that it now claims."

But the battle isn't over. Hollywood's lobbyists are pushing a bill now that would allow the FCC to regulate PCs, receivers, even camcorders—anything that could be used in connection with "indiscriminate Internet redistribution." They're trying to find a politician who will commit career suicide by introducing it. But you can fight it: Send your elected rep a note at action.eff.org. ■

SCIENCE FRICTION

THE MARKETING AND MANGLING OF SCIENCE IN POPULAR CULTURE

BY GREGORY MONE



Trust Me — I'm a Robot

THE ISSUE: Hollywood androids are dysfunctional human wannabes. Real AI researchers are devising something else

HERE'S SOMETHING THAT ENGINEERS DESIGNING THE NEXT GENERATION OF unmanned combat air vehicles may not have considered: A well-placed lightning strike could rewire the plane's artificially intelligent (AI) brain, transforming the craft into an enemy of the state bent on destroying a major city. Absurd? Maybe. Good plot for a thriller? Evidently: It's the source of the action in the new movie *Stealth*, in which an AI-controlled fighter jet turns evil.

Artificial intelligence has returned to the big screen in a big way in recent years,

HUMAN MINDS, SYNTHETIC BODIES A doomsday view of robots prevails in [clockwise from top left] *Stealth*; 2001: *A Space Odyssey*; *I, Robot*; *Artificial Intelligence: AI* and *Bicentennial Man*.

THIS PAGE: COLUMNIST ILLUSTRATION: ROB KELLY; COLUMNIST PHOTOGRAPH: HENRY MARC PEREZ; CLOCKWISE FROM TOP LEFT: COLUMBIA/NEAL PETERS COLLECTION; MCGRAW-HILL/NEAL PETERS COLLECTION; 20TH CENTURY FOX/NEAL PETERS COLLECTION; WARNER BROS./NEAL PETERS COLLECTION; TOUCHSTONE/NEAL PETERS COLLECTION; FACING PAGE: COLUMBIA/NEAL PETERS COLLECTION

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but Hollywood hasn't offered much new thinking on the subject. *Artificial Intelligence: AI* (2001) was based on a 30-year-old short story by Brian Aldiss. *Bicentennial Man* (1999) and *I, Robot* (2004) grew out of old Isaac Asimov tales. And the AI in *Stealth* is essentially HAL 9000 from *2001: A Space Odyssey*—but with less personality and more missiles at its disposal. Martha Pollack, an AI researcher at the Univer-

sity of Michigan, says this type of story owes more to Godzilla than to real-world research: "An intelligent creature that we can't understand goes crazy and does evil things."



OUTSMARTING THE MACHINE *Stealth*, which stars Josh Lucas and Jamie Foxx, pits human pilots against an artificially intelligent aircraft gone bad.

I certainly understand that the man-versus-machine bit makes for good thrillers. And that moviegoers embrace stories about Anthropomorphic Robots Who Can Do Everything . . . But Love. The little tear dribbling out of the robotic eye—I get it. My gripe isn't with the lack of realism so much as the way these films inflate expectations, making actual advances seem mundane. Case in point: Last year's DARPA Grand Challenge robot-vehicle race. The event took place three years after HAL 9000 was supposed to have been killing astronauts on the way to Jupiter (not to men-

tion 36 years after the movie came out), so I expected more than just a bunch of vehicles eking out a few off-road miles before stalling out or self-destructing. Not only did I want to see the winner cross the finish line, I envisioned it standing up on its rear wheels, taking a bow, and saying something to the effect of: "I'd like to thank all the wonderful humans at Carnegie Mellon. Without them, I wouldn't be here . . ."

In the past, wild expectations have, when dashed, slowed real-world research. The boom in AI research in the 1980s was fueled in part by science-fiction visions in books and movies, in part by the grand prognostications of early pioneers, plus a little cross-Pacific competition with the Japanese. When it failed to produce anything approximating Robby the Robot, funding dried up, and a period now known in the field as the AI winter set in. It's unclear whether the chill actually delayed progress—or whether it allowed researchers to step out of the limelight and refocus their efforts to make real advances. Either way, with AI now running our junk-mail filters and gaming consoles, the technology is back.

But not in the form of the do-everything brains beloved by Hollywood. Today's AI is task-oriented—what Pollack calls "niche intelligences." One of her projects is designed to track whether an elderly person is taking his medicine, and to prompt him to pop a pill if he forgets. This doesn't measure up to the



Get on your own soapbox!
Write to pluggedin@time4.com
or sciencefriction@time4.com.

vegetable-dicing, dog-walking NS-5s in *I, Robot*, but it's still pretty cool.

Not everyone is convinced that such narrow utility is the ultimate horizon for AI, of course. Pollack says many researchers still dream of the humanlike robot. And if we ever do get to that point, the movies have provided us with a few helpful warnings. For example, fathers will need to keep their eyes peeled for robotic suitors. In *Bicentennial Man*, unsuspecting parents pur-

Quit wondering when you'll have a **robot slave** to get your coffee, and start thanking your spam filter.

chase a household robot for domestic chores, only to have their daughter fall for it. This is an unsettling prospect, but Gigolo Joe, the robotic male prostitute played by Jude Law in *AI*, is even more frightening. Beyond his superior physical endowments, he's programmed to always say the right things. That's hard to compete with. Another rule is to always check your AI for homicidal tendencies. The voice is a particularly good giveaway. If it sounds anything like HAL, it's either low on batteries, high or evil. And if *Stealth* is any indication, it's probably not a good idea to give our AIs too many weapons, either.

My advice: Quit wondering when you'll have an affordable, brilliant robot slave to run out and get your coffee, and start thanking your spam filter and its more homely intelligence. It won't answer back today, but my research at the movies convinces me that someday it will. ■

WHERE SCIENCE AND POP CULTURE COLLIDE THIS MONTH

➤ **GRIZZLY MAN** This documentary explores the life and death of outdoorsman Timothy Treadwell using Treadwell's own video footage, taken during years of living—much too closely, as it turns out—with Alaskan grizzlies. Opens August 5.

➤ **THE CAVE** Spelunkers descend into one of the world's largest cave systems, where they hold forth on some of the finer points of crystal formation and . . . just kidding. They're attacked by monsters. Opens August 26.

➤ **DEAD RAIL** A meteor carrying tiny but deadly aliens crashes in the Nevada desert, interfering with the inaugural run of a bullet train. Debuts on the Sci-Fi Channel in August.

- ☒ Treat the Trans-Canada Highway like the back straight.
- ☒ Ride until English becomes a foreign language.
- ☐ Do in a few days what took Lewis and Clark a few years.
- ☐ Briefly imagine competing in MotoGP.

☒ TAKE THE WIFE ASPHALT DANCING.

- ☐ Seek out questionable hotel rooms everywhere.
- ☒ Make the entire country your racetrack.
- ☒ Have more weather protection than most homes.
- ☐ Scream through the twisties with 35 liters of stowage space.
- ☒ Go somewhere for a change.
- ☒ Realize that a touring bike doesn't have to handle like an oil barge.
- ☐ Look sensible. Ride maniacal.

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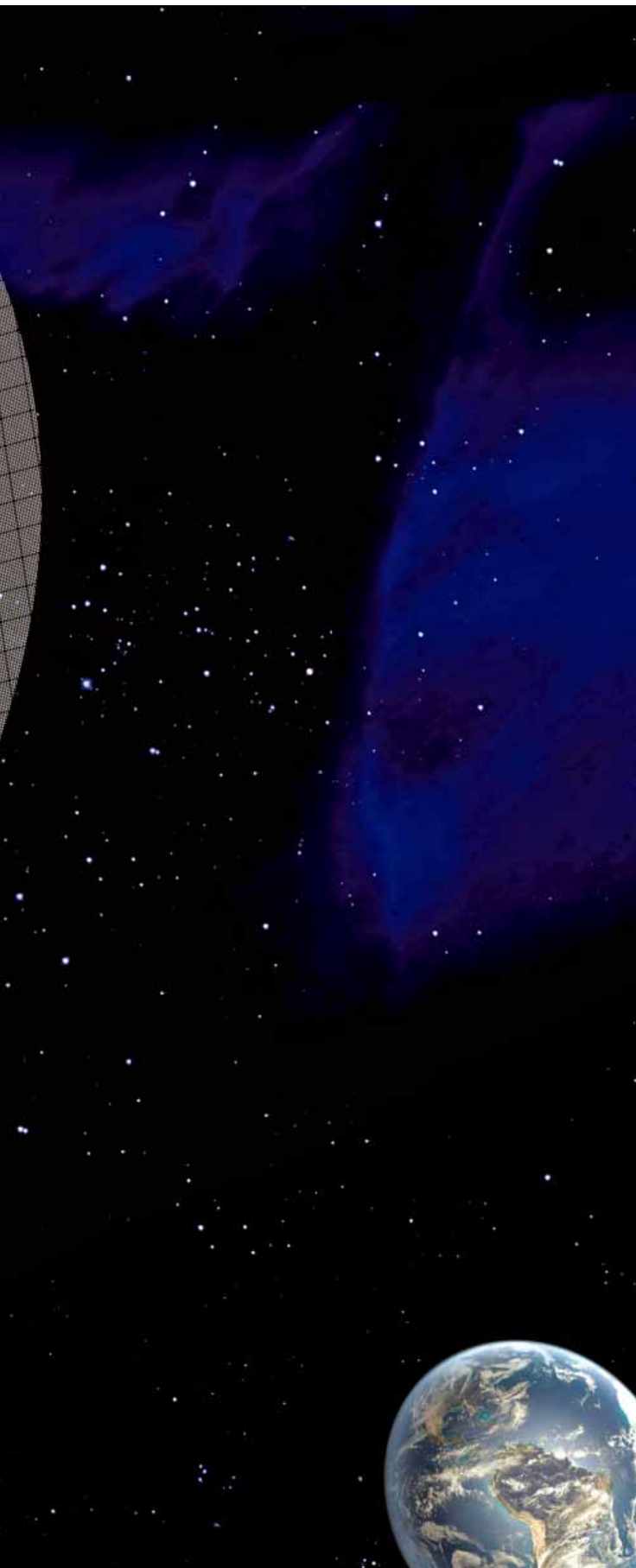


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SUN SCREEN Stationed between the Earth and sun at a point where the gravitational forces nearly cancel each other out, a 600,000-square-mile space "mirror" scatters sunlight with a mesh woven of fine metal wires.

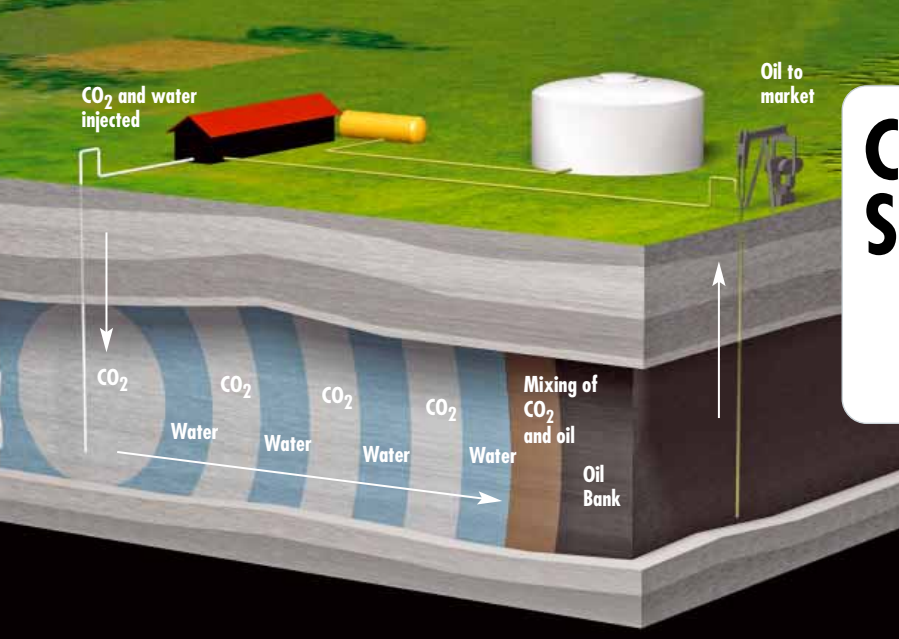


BY MICHAEL BEHAR
ILLUSTRATIONS BY JOHN MACNEILL

DAVID KEITH NEVER EXPECTED TO GET A SUMMONS FROM THE White House. But in September 2001, officials with the President's Climate Change Technology Program invited him and more than two dozen other scientists to participate in a roundtable discussion called "Response Options to Rapid or Severe Climate Change." While administration officials were insisting in public that there was no firm proof that the planet was warming, they were quietly exploring potential ways to turn down the heat.

Most of the world's industrialized nations had already vowed to combat global warming by reining in their emissions of carbon dioxide, the chief "greenhouse gas" blamed for trapping heat in Earth's atmosphere. But in March 2001 President George W. Bush had withdrawn U.S. support for the Kyoto Protocol, the international treaty mandating limits on CO₂ emissions, and asked his administration to begin studying other options.

Keith, a physicist and economist in the chemical and petroleum engineering department at the University of



CO₂ PUMPING SYSTEMS

Carbon dioxide and water are injected underground at high pressure to push oil out of rock. Some of the CO₂ stays behind.



Calgary, had for more than a decade been investigating strategies to curtail global warming. He and the other scientists at the meeting—including physicists from Lawrence Livermore National Laboratory who had spent a chunk of their careers designing nuclear weapons—had come up with some ideas for “geoengineering” Earth’s climate. What they proposed was tinkering on a global scale. “We already are inadvertently changing the climate, so why not *advertently* try to counterbalance it?” asks retired Lawrence Livermore physicist Michael MacCracken, a former senior scientist at the U.S. Global Change Research Program who helped organize the meeting.

“If they had broadcast that meeting live to people in Europe, there would have been riots,” Keith says. “Here were the bomb guys from Livermore talking about stuff that strikes most greens as being completely wrong and off-the-wall.” But today, a growing number of physicists, oceanographers and climatologists around the world are seriously considering technologies for the deliberate manipulation of Earth’s climate. Some advocate planetary air-conditioning devices such as orbiting space mirrors that deflect sunlight away from Earth, or ships that intensify cloud cover to block the sun’s rays. Others are suggesting that we capture carbon dioxide—from the air, from cars and power plants—and stash it underground or react it with chemicals that turn it to stone.

Carbon dioxide wasn’t always public enemy number one.

For the past 400,000 years, the concentration of CO₂ in the atmosphere has fluctuated between about 180 and 280 ppm (parts per million, the number of CO₂ molecules per million molecules of air). But in the late 1800s, when humans set about

burning fossil fuels in earnest, atmospheric CO₂ began to increase with alarming speed—from about 280 ppm to the current level of almost 380 ppm, in a scant 100 years. Experts predict that CO₂ could climb as high as 500 ppm by 2050 and possibly twice that by the end of the century. As CO₂ levels continue to rise, the planet will get hotter. “The question now,” says Ken Caldeira, an atmospheric scientist at Lawrence Livermore and one of the world’s leading authorities on climate change, “is what can we actually do about it?” Here are some of the geoengineering schemes under consideration.



1 STORE CO₂ UNDERGROUND

FEASIBILITY: 10 COST: \$\$ RISK: 4

In the southeastern corner of Saskatchewan, just outside the town of Weyburn—the “Opportunity City”—a steel pipeline descends 4,000 feet below the prairie at the edge of a 70-square-mile oil field. Into this subterranean cavern, petroleum engineers are pumping 5,000 tons of pressurized, liquefied carbon dioxide every day. The aim is twofold: Use high-pressure CO₂ to drive oil from the porous rock in the reservoir to the surface, and trap the carbon dioxide underground.

Welcome to the world’s largest carbon-sequestering operation. Dubbed the Weyburn Project, it began in July 2000 as a partnership between EnCana, a Canadian oil and gas company, and Canada’s Petroleum Technology Research Centre. With \$13 million in funding from more than a dozen sponsors, including the U.S. Department of Energy, engineers have already socked away six million tons of carbon dioxide, roughly the amount produced by burning half a billion gallons of gasoline.

THE TIMELINE Unlike other geoengineering schemes, this one is already happening, with more than half a dozen major projects under way. The problem, says Howard Herzog, a prin-

WIND SCRUBBERS

Giant air filters, mounted on towers and continuously wetted with a binding chemical, snag CO₂ molecules as they float past in the wind.

KEY»

FEASIBILITY: From 1 (major breakthrough required) to 10 (could be done with existing technology)

COST: From \$ (a few pennies per gallon in gas taxes) to \$\$\$\$ (next Manhattan Project)

RISK: From 1 (totally safe) to 10 (could end life as we know it)

cial research engineer at MIT's Laboratory for Energy and the Environment, is that concentrated CO₂ is in short supply. There's too much of the gas floating around in the air, but actually capturing, compressing, and transporting it costs money. In the U.S. and most other nations, there are no laws requiring fossil-fuel-burning power plants—the primary source of CO₂ emissions—to capture a single molecule of the gas.

THE PROMISE By 2033, the Weyburn Project will store 25 million tons of carbon dioxide. “That’s like taking 6.8 million cars off the road for one year,” says project manager Mike Monea, “and this is just a pilot test in a small oil reservoir.” Saline aquifers, giant pools of saltwater that have been trapped underground for millions of years, could hold even more CO₂. Humans dump about 28 gigatons of CO₂ into the atmosphere every year. Geologists estimate that underground reservoirs and saline aquifers could store as much as 200,000 gigatons.

THE PERILS Before CO₂ is injected into the ground, it’s compressed into what’s called a supercritical state—it’s extremely dense and viscous, and behaves more like a liquid than a gas. In this form, CO₂ should remain trapped underground for thousands of years, if not indefinitely. The danger is if engineers accidentally “depressurize” an aquifer while probing for oil or natural gas. There’s also a risk that carbon dioxide could escape slowly through natural fissures in subterranean rock and pool up in basements or cellars. “If you walked down into a basement [full of CO₂],” Keith says, “you wouldn’t smell it or see it, but it would kill you.”

2 FILTER CO₂ FROM THE AIR

FEASIBILITY: 4 COST: \$\$\$ RISK: 4

Klaus Lackner is accustomed to skeptics. They’ve doubted him since he first presented his idea for extracting carbon dioxide from ambient air in March 1999, at an interna-

tional symposium on coal and fuel technology. “The reaction from everyone there was utter disbelief,” recalls Lackner, a physicist with the Earth Engineering Center at Columbia University.

He called for the construction of giant filters that would act like flypaper, trapping CO₂ molecules as they drifted past in the wind. Sodium hydroxide or calcium hydroxide—chemicals that bind with carbon dioxide—would be pumped through the porous filters much the way antifreeze is circulated through a car’s radiator. A secondary process would strip the CO₂ from the binding chemical. The chemical would recirculate through the filter, while the CO₂ would be set aside for disposal.

THE TIMELINE Lackner is collaborating with engineer Allen Wright, who founded Global Research Technologies in Tucson, Arizona. Wright is developing a wind-scrubber prototype but remains tight-lipped about the project. He estimates that a completed system is at least two years away.

THE PROMISE Wind scrubbers can be placed wherever it’s convenient to capture carbon dioxide, so there’s no need to transport it. Lackner calculates that a wind scrubber designed to retain 25 tons of CO₂ per year—the average amount each American adds to the atmosphere annually—would require a device about the size of a large plasma-screen television. A single industrial-size wind scrubber about 200 feet high and 165 feet wide would snag about 90,000 tons of CO₂ a year.

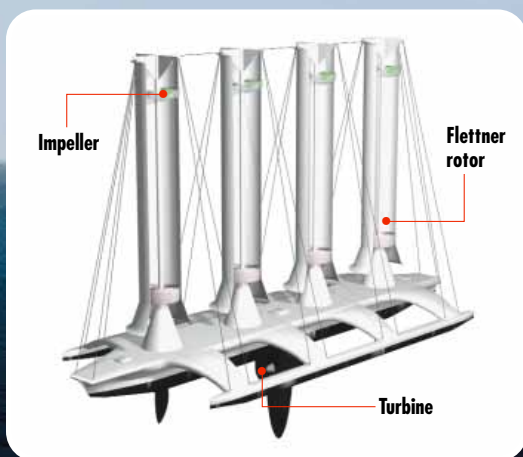
THE PERILS Some experts are dubious about the ease of separating carbon dioxide from the binding chemical, a process that in itself would require energy from fossil fuels. “CO₂ is so dilute in the air that to try to scrub from it, you have to pay too much for energy use,” Herzog says. And to capture all the carbon dioxide being added to the atmosphere by humans, you’d need to blanket an area at least the size of Arizona with scrubber towers.



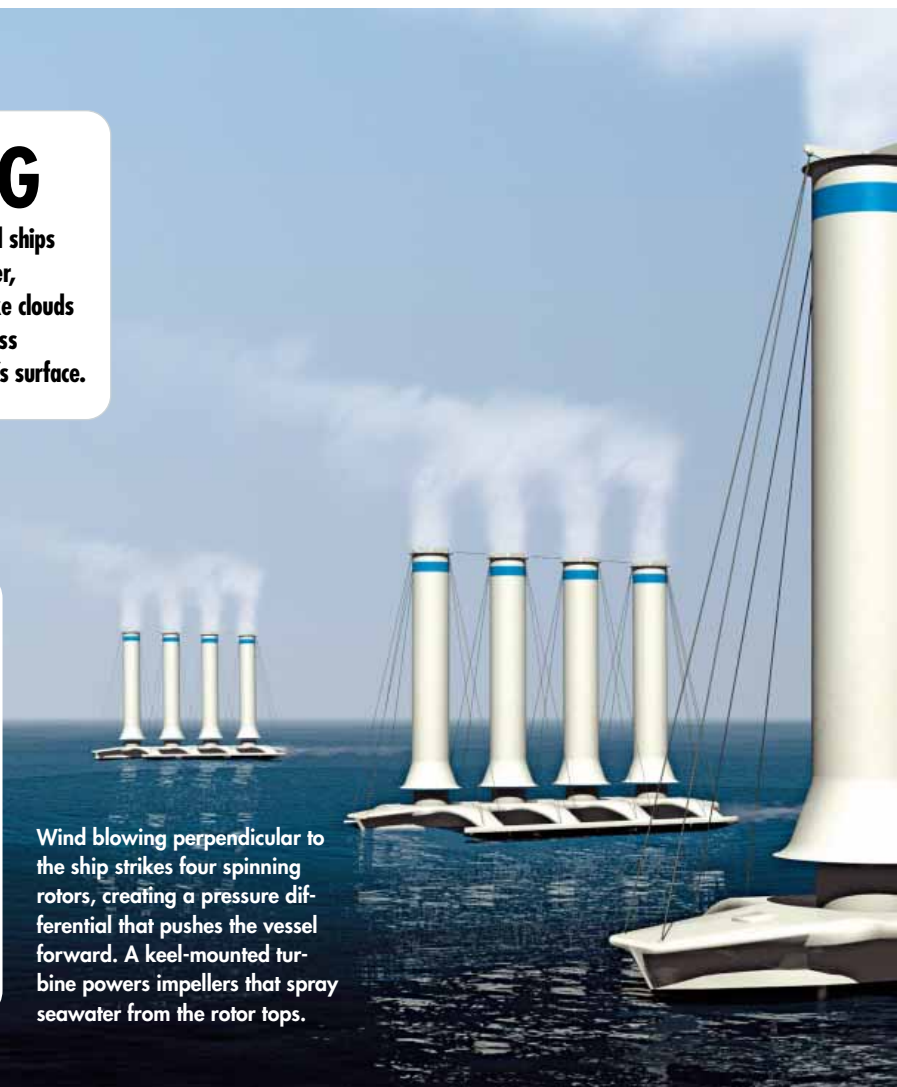
CLOUD-BOOSTING YACHTS

Salt spray from unmanned ships drifts up to the cloud layer, forming droplets that make clouds more reflective so that less sunlight reaches the Earth's surface.

5



Wind blowing perpendicular to the ship strikes four spinning rotors, creating a pressure differential that pushes the vessel forward. A keel-mounted turbine powers impellers that spray seawater from the rotor tops.



3

FERTILIZE THE OCEAN

FEASIBILITY: 10 COST: \$ RISK: 9

On January 5, 2002, *Revelle*, a research vessel operated by the Scripps Institution of Oceanography, left New Zealand for the Southern Ocean—a belt of frigid, stormy seas that separates Antarctica from the rest of the world. There the scientists dumped almost 6,000 pounds of iron powder overboard and unleashed an armada of instruments to gauge the results.

The intent was to test a hypothesis put forth by oceanographer John Martin. At a lecture more than a decade ago, Martin declared: “Give me a half-tanker of iron, and I will give you an ice age.” He was alluding to the fact that the Southern Ocean is packed with minerals and nutrients but strangely devoid of sea life. Martin had concluded that the ocean was anemic—containing very little iron, an essential nutrient for plankton growth. Adding iron, Martin believed, would cool the planet by triggering blooms of CO₂-consuming plankton.

Oceanographer Kenneth Coale, who directs the Moss Landing Marine Laboratories near Monterey, California, was a chief scientist on the Southern Ocean cruise. He says the project was a success, proving that relatively small quantities of iron could spawn colossal blooms of plankton.

THE TIMELINE Scientists are wary, saying that too little is known about the deep-ocean environment to endorse further large-scale experiments. In October, Coale and other scientists will gather in New Zealand for a weeklong meeting sponsored by the National Science Foundation, New Zealand’s National Institute for Water and Atmosphere, and the International Geosphere-Biosphere Programme to decide how to proceed.

THE PROMISE Iron fertilization is by far the cheapest and easiest way to mitigate carbon dioxide. Coale estimates that just one pound of iron could conceivably hatch enough plankton to sequester 100,000 pounds of CO₂. “Even if the process is only 1 percent efficient, you just sequestered half a ton of carbon for a dime.”

THE PERILS “What is still a mystery,” Coale says, “is the ripple effect on the rest of the ocean and the food chain.” One fear is that huge plankton blooms, in addition to gorging on CO₂, will devour other nutrients. Deep currents carry nutrient-rich water from the Southern Ocean northward to regions where fish rely on the nutrients to survive. Says Coale, “A fertilization event to take care of atmospheric CO₂ could have the unintended consequence of turning the oceans sterile. Oops.”



4

TURN CO₂ TO STONE

FEASIBILITY: 7 COST: \$\$ RISK: 3

The Grand Canyon is one of the largest carbon dioxide repositories on Earth. Hundreds of millions of years ago, a vast sea covered the land there. The water, rich in carbon dioxide, slowly reacted with other chemicals to create calcium carbonate, or limestone—the pinkish bands striping the canyon walls today.

Nature's method for turning CO₂ to stone is achingly slow, but researchers at the Goldwater Materials Science Laboratory at Arizona State University are working on a way to speed up the process. Michael McKelvy and Andrew Chizmeshya use serpentine or olivine, widely available and inexpensive minerals, as feedstock to fuel a chemical reaction that transforms CO₂ into magnesium carbonate, a cousin of limestone. To initiate the reaction—known as “mineral carbonation”—the CO₂ is compressed, heated, and mixed with feedstock and a catalyst, such as sodium bicarbonate (baking soda).

THE TIMELINE Scaling up the process to handle millions of tons of CO₂ would require huge quantities of serpentine or

olivine. A single mineral-carbonation plant would carve out a mountain, but, McKelvy says, “You could carbonate [the CO₂] and put it right back where the feedstock came from.”

THE PROMISE Mineral carbonation is simply an accelerated version of a benign natural process. The limestone in the Grand Canyon is 500 feet thick, McKelvy says, “and it has been sitting there not bothering anybody for millennia.”

THE PERILS It costs roughly \$70 to eliminate one ton of CO₂, a price that McKelvy says is too high. Also, the feedstock and CO₂ must be heated to high temperatures. “You wind up having to burn fossil fuels in order to provide the energy to activate the mineral to put away the CO₂,” he says.

5

ENHANCE CLOUDS TO REFLECT SUNLIGHT

FEASIBILITY: 6 COST: \$\$ RISK: 7

Some proposed solutions to global warming don't involve capturing carbon dioxide. Instead they focus on turning down the heat by deflecting or filtering incoming sunlight.

On any given day, marine stratocumulus clouds blanket about one third of the world's oceans, mostly around the tropics. Clouds form when water vapor clings to dust or other particles, creating droplets. Seeding clouds with tiny salt particles would enable more droplets to form—making the clouds whiter and therefore more reflective. According to physicist John Latham, a senior research associate at the National Center for Atmospheric Research in Boulder, Colorado, boosting reflectivity, or albedo, in just 3 percent of marine stratocumulus clouds would reflect enough sunlight to curb global warming. “It would be like a mirror for incoming solar radiation,” Latham explains.

Latham is collaborating with Stephen Salter, an emeritus professor of engineering design at the University of Edinburgh, who is making sketches for GPS-steered wind-powered boats that would cruise the tropical latitudes, churning up salt spray. “I am planning a flotilla of unmanned yachts sailing backward and forward across the wind,” Salter says. “They would drag propellers through the water to generate electricity, which we'd use to make the spray.”

Salter wants to outfit each boat with four 60-foot-tall Flettner rotors, which look like smokestacks but act like sails. An electric motor starts each rotor spinning, which, along with the wind, creates a pressure differential (less pressure in front of the rotor, more in back), generating forward thrust. From the top of the rotor, an impeller would blast a fine saltwater mist into the air.

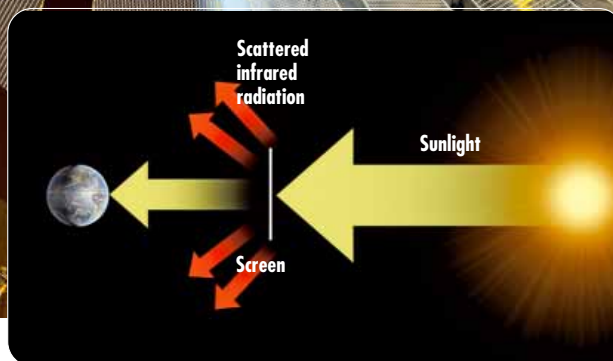
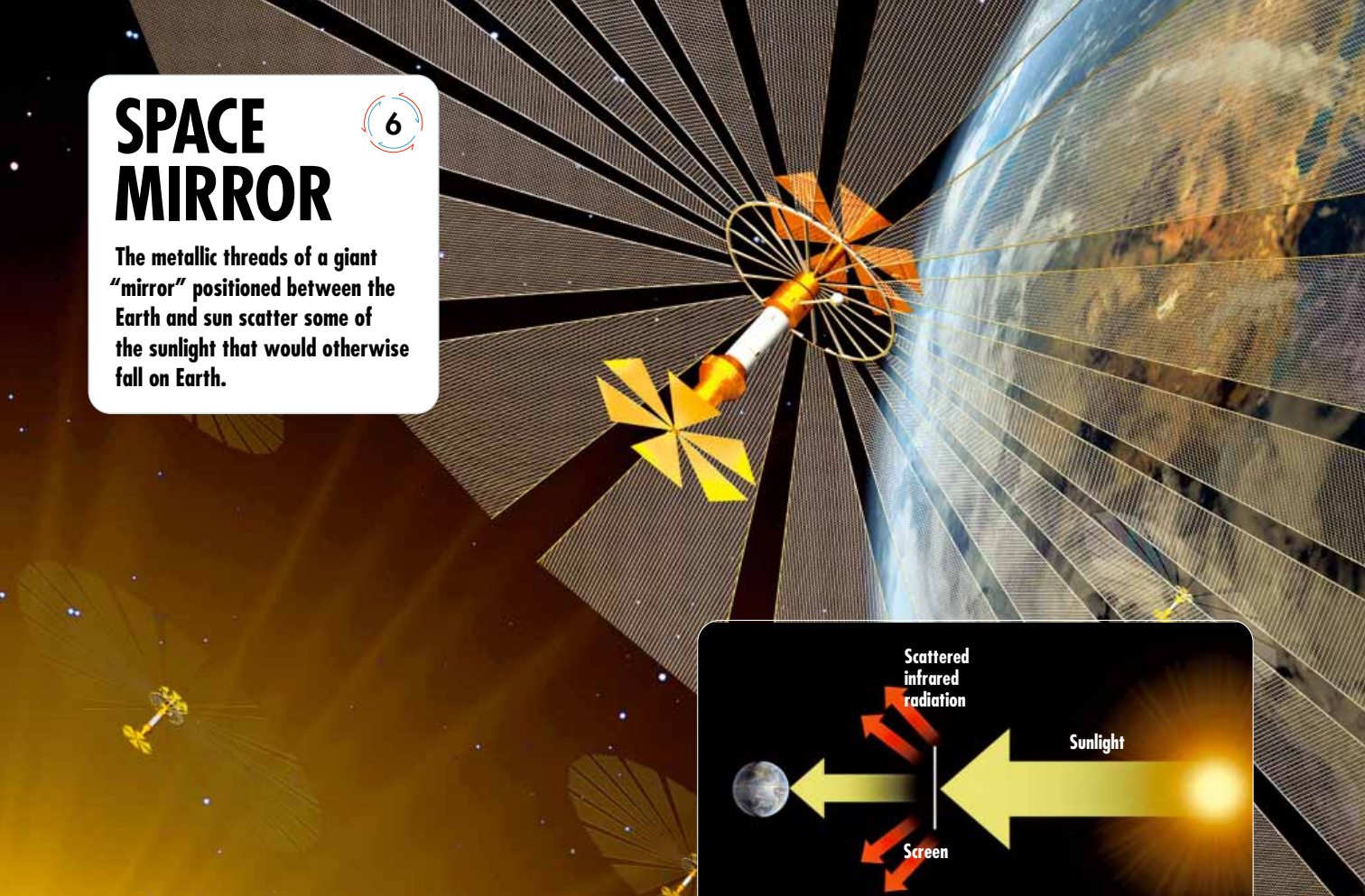
Until the concept is tested, Salter isn't sure exactly how many ships would be needed to mitigate global warming. “Maybe between 5,000 and 30,000,” he says. That may sound like a lot, but Salter notes that for World War II, the U.S. built nearly 100,000 aircraft in 1944 alone.

THE TIMELINE Latham initially raised the notion in a 1990 paper. “The article went down like a lead balloon,” he says. But early last year in England, at a geoengineering conference hosted by MIT and the Tyndall Centre for Climate Change Research, he presented the concept again. “The consensus was that a number of ideas originally thought to be outlandish were deemed sufficiently plausible to be supported further. Our

SPACE MIRROR

6

The metallic threads of a giant “mirror” positioned between the Earth and sun scatter some of the sunlight that would otherwise fall on Earth.



work fell into that category.” Latham needs a few million dollars to test his idea. “On the scale of the damage that will be caused by global warming, that is utterly peanuts.”

THE PROMISE What’s nice about this idea is that it can easily be fine-tuned. “If we tried it and there was some deleterious effect, we could switch it off, and within four or five days all evidence would have disappeared,” Latham says.

THE PERILS One worry is that although the tiny salt particles released by evaporating sea mist are perfect for marine stratocumulus-cloud formation, they are too small to create rain clouds. “You might make it harder for rain to form,” Salter says. “Therefore, you would not want to do this upwind of a place where there is a bad drought.”

6

DEFLECT SUNLIGHT WITH A MIRROR

FEASIBILITY: 1 COST: \$\$\$\$ RISK: 5

One of the most ambitious schemes is a giant space “mirror” positioned between the Earth and sun to intercept sunlight. To build the mirror, physicist Lowell Wood, a senior staff scientist at Lawrence Livermore, proposes using a mesh of

aluminum threads that are only a millionth of an inch in diameter and a thousandth of an inch apart. “It would be like a window screen made of exceedingly fine metal wire,” he explains. The screen wouldn’t actually block the light but would simply filter it so that some of the incoming infrared radiation wouldn’t reach Earth’s atmosphere.

THE TIMELINE Wood, who has been researching the mirror idea for more than a decade, says it should be considered only as a safety net if all other means of reversing global warming “fail or fall grossly short over the next few decades.”

THE PROMISE Once in place, the mirror would cost almost nothing to operate. From Earth, it would look like a tiny black spot on the sun. “People really wouldn’t see it,” says Michael MacCracken. And plant photosynthesis isn’t expected to be affected by the slight reduction in sunlight.

THE PERILS Wood calculates that deflecting 1 percent of incoming solar radiation would stabilize the climate, but doing so would require a mirror spanning roughly 600,000 square miles—or several smaller ones. Putting something that size in orbit would be a massive challenge, not to mention exorbitantly expensive. ■

POPSCI ON THE WEB It's nice to fool Mother Nature. Making small earthquakes to avoid the big one: popsci.com/engineering

Michael Behar, a science and adventure-travel writer in Arlington, Virginia, combats global warming by cutting his lawn with a push-reel mower.

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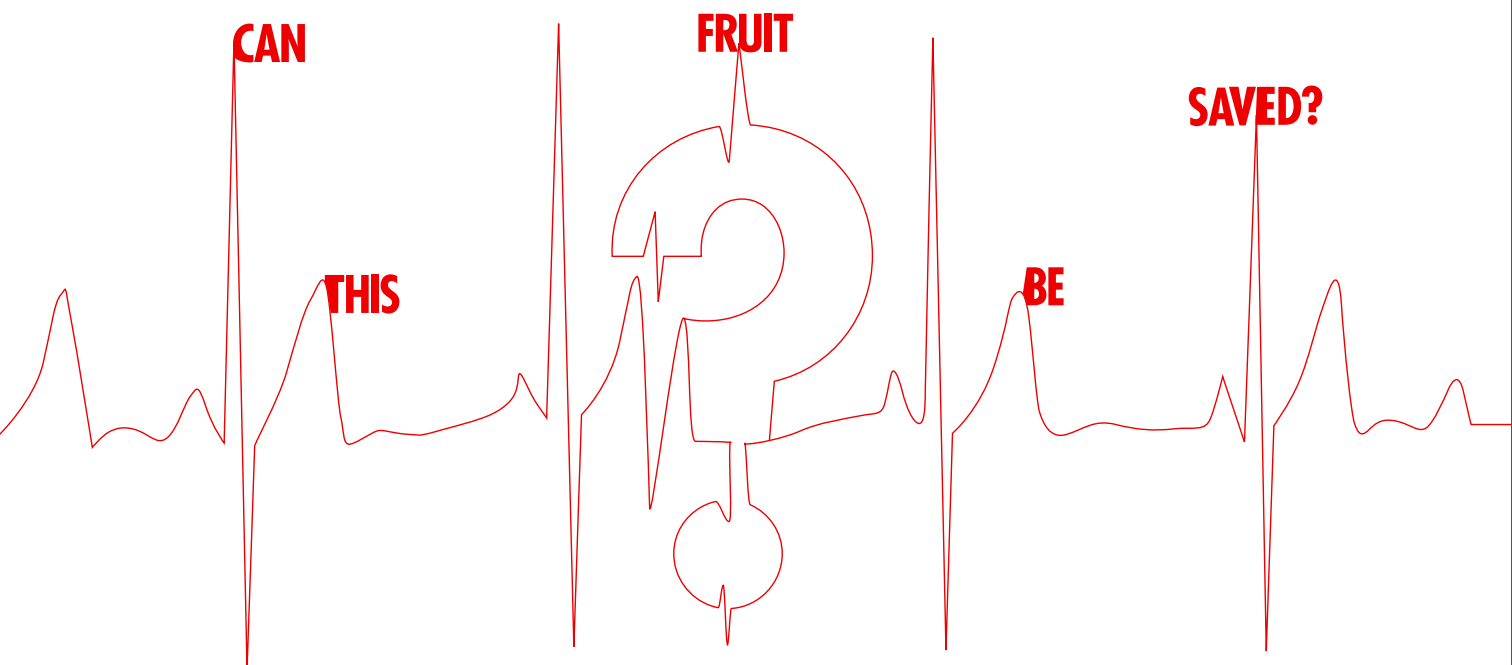


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The banana as we
know it is on a
collision course
with extinction.
The race to revive
it is a competition
between traditional
horticulture and
cutting-edge
bioengineering

BY DAN KOEPPPEL



PHOTOGRAPH BY JOHN B. CARNETT

“A BANANA,” SAYS JUAN FERNANDO AGUILAR, “IS not just a banana.” The bearded botanist and I are traipsing through one of the world’s most unusual banana plantations, moving down row after row of towering plants and ducking into the shade of broad leaves in an attempt to avoid the Central American midday heat. In an area about the size of a U.S. shopping mall, Aguilar, 46, is growing more than 300 banana varieties. Most commercial growing facilities handle just a single banana type—the one we Americans slice into our morning cereal.

The diversity of fruit in Aguilar’s field is astonishing. Some of the bananas are thick and over a foot long; others are slender and pinky-size. Some are meant to be eaten raw and sweet and some function more like potatoes, meant for boiling and baking or frying into snack chips. But Aguilar’s admonition is aimed squarely at our northern lunch boxes and breakfast tables.

For nearly everyone in the U.S., Canada and Europe, a banana is a banana: yellow and sweet, uniformly sized, firmly textured, always seedless. Our banana, called the Cavendish, is one variety Aguilar doesn’t grow here. “And for you,” says the chief banana breeder for the Honduran Foundation for Agricultural Investigation (FHIA), “the Cavendish is the banana.”

The Cavendish—as the slogan of Chiquita, the globe’s largest banana producer, declares—is “quite possibly the world’s perfect food.” Bananas are nutritious and convenient; they’re cheap and consistently available. Americans eat more bananas than any other kind of fresh fruit, averaging about 26.2 pounds of them per year, per person (apples are a distant second, at 16.7 pounds). It also turns out that the 100 billion Cavendish bananas consumed annually worldwide are perfect from a genetic standpoint, every single one a duplicate of every other. It doesn’t matter if it comes from Honduras or Thailand, Jamaica or the Canary Islands—each Cavendish is an identical twin to one first found in Southeast Asia, brought to a Caribbean botanic garden in the early part of the 20th century, and put into commercial production about 50 years ago.

That sameness is the banana’s paradox. After 15,000 years of human cultivation, the banana is too perfect, lacking the genetic diversity that is key to species health. What can ail one banana can ail all. A fungus or bacterial disease that infects one plantation could march around the globe and destroy millions of bunches, leaving supermarket shelves empty.

A wild scenario? Not when you consider that there’s already been one banana apocalypse. Until the early 1960s, American cereal bowls and ice cream dishes were filled with the Gros Michel, a banana that was larger and, by all accounts, tastier than the fruit we now eat. Like the Cavendish, the Gros Michel, or “Big Mike,” accounted for nearly all the sales of sweet bananas in the Americas and Europe. But starting in the early

part of the last century, a fungus called Panama disease began infecting the Big Mike harvest. The malady, which attacks the leaves, is in the same category as Dutch Elm disease. It appeared first in Suriname, then plowed through the Caribbean, finally reaching Honduras in the 1920s. (The country was then the world’s largest banana producer; today it ranks third, behind Ecuador and Costa Rica.)

Growers adopted a frenzied strategy of shifting crops to unused land, maintaining the supply of bananas to the public but at great financial and environmental expense—the tactic destroyed millions of acres of rainforest. By 1960, the major importers were nearly bankrupt, and the future of the fruit was in jeopardy. (Some of the shortages during that time entered the fabric of popular culture; the 1923 musical hit “Yes! We Have No Bananas” is said to have been written after songwriters Frank Silver and Irving Cohn were denied in an attempt to purchase

their favorite fruit by a syntactically colorful, out-of-stock neighborhood grocer.) U.S. banana executives were hesitant to recognize the crisis facing the Gros Michel, according to John Soluri, a history professor at Carnegie Mellon University and author of *Banana Cultures*, an upcoming book on the fruit. “Many of them waited until the last minute.”

Once a little-known species, the Cavendish was eventually accepted as Big Mike’s replacement after billions of dollars in infrastructure changes were made to accommodate different growing and ripening needs. Its advantage was its resistance to Panama disease. But in 1992, a new strain of the fungus—one that can affect the Cavendish—was discovered in Asia.

Since then, Panama disease Race 4 has wiped out plantations in Indonesia, Malaysia, Australia and Taiwan, and it is now spreading through much of Southeast Asia. It has yet to hit Africa or Latin America, but most experts agree that it is coming. “Given today’s modes of travel, there’s almost no doubt that it will hit the major Cavendish crops,” says

SEEDS OF CHANGE
Workers harvest pollen (1) and use it to manually fertilize female flowers (2), a job performed with a bike and ladder (3). The resulting fruits are searched for viable seeds (4), which germinate in the lab’s “embryo rescue unit” (5). The plants move through a series of greenhouses overseen by lab director Adolfo Martinez (6) before being transplanted to the fields. From pollination to harvest (7), the process takes two years.

Randy Ploetz, the University of Florida plant pathologist who identified the first Sumatran samples of the fungus.

A global effort is now under way to save the fruit—an effort defined by two opposing visions of how best to address the looming crisis. On one side are traditional banana growers, like Aguilar, who raise experimental breeds in the fields, trying to create a replacement plant that looks and tastes so similar to the Cavendish that consumers won’t notice the difference. On

**ARE EMPTY SUPERMARKET SHELVES A WILD SCENARIO?
NOT WHEN YOU CONSIDER THE LAST BANANA APOCALYPSE.**



1



2



3



4



5



6



7

SCIENTISTS ARE IN A RACE—AGAINST ONE ANOTHER, FOR CERTAIN,

the other side are bioengineers like Rony Swennen, who, armed with a largely decoded banana genome, are manipulating the plant's chromosomes, sometimes crossing them with DNA from other species, with the goal of inventing a tougher Cavendish that will resist Panama disease and other ailments.

Banana experts disagree on when the Latin American and African crops will be hit by the Panama fungus. Ploetz won't venture a guess, but he notes that the Malaysian plantations went from full-scale commercial operations to "total wipeout" in less than five years. Currently, there is no way to effectively combat Panama disease and no Cavendish replacement in sight. And so traditional scientists and geneticists are in a race—against one another, for certain, but mostly against time.



Honduras is in many ways the epicenter of the American super-market banana. More than a century ago, a pair of U.S. companies—United Fruit and Standard Fruit, now known, respectively, as Chiquita and Dole—built some of the world's first commercial banana plantations in the Central American nation. Technological infrastructure was the first task: The banana producers began as railroad companies, with friendly local governments granting thousands of acres of surrounding rainforest for each mile of track laid. Although bananas had been sporadically available in the U.S. since colonial days, the post-Civil War advent of motorized transit by rail and steamship made the importation of tropical fruit practical. (An 1896 article in this magazine entitled "Where Bananas Grow" observed that the U.S. market for bananas had increased more than 40-fold in the previous quarter century, owing mostly to

improved "facilities for transporting and preserving them.")

By the early 1900s, bananas surpassed apples as the nation's favorite fruit, becoming so popular that in the days before municipal trash collection, the slapstick slip on a discarded peel was a genuine hazard. (Luckily, Boy Scouts were on the case: "A good turn may consist in removing a piece of banana peel from the pavement," their 1914 handbook advised.) The problem of banana litter helped lead to the development of the earliest urban refuse-removal networks, according to Virginia Scott Jenkins, author of *Bananas: An American History*.

Bananas have always been a technology incubator. Because they're a time-sensitive product—they need to be harvested green, then delivered to market just at ripening time—systems



had to be developed to bring precision to the picking and shipping processes. Leonel Castillo, a banana-production consultant who grew up in Chiquita's corporate compound near the city of San Pedro Sula, on Honduras's northern coast, explains that the old way was "to wait until you could see the ship coming over the horizon toward port." Then banana workers would engage in frantic nonstop harvesting and rush the crop to the boats. Chiquita engineers developed the first radio networks in the tropics as a way to bypass this antiquated system. The fruit's popularity also led to the development of ripen-

**POPSCI
ON THE WEB**

Take a virtual photographic tour of
FHIA's Honduran operation at
popsci.com/banana.

FROM LEFT: JEFFREY WEISS; JONATHAN WORTH

BUT MOSTLY AGAINST TIME.

ing rooms whose controlled environment can slow or speed the way picked fruit ages; refrigerated steamships; and early precursors to bar-coding that allowed each bunch to be tracked by field, plantation, originating country and shipping container.

But the main thrust of banana tech has always been the search for new varieties. FHIA now occupies the buildings at Chiquita's old Honduran headquarters that since the 1920s have been the global hub for traditional banana breeding (the buildings also hint at the lifestyle once provided for executives at tropical outposts, spreading across a campus-like compound that once housed a swimming pool and horse-racing track).

Chiquita abandoned most tropical research in the 1970s; FHIA opened in 1986 as part of an initiative to promote local economic development. One of the first new breeds to come out of the effort, which is funded by a combination of government and private grants, was the "Goldfinger" banana, also known as FHIA-01. The Goldfinger was developed by painstakingly cross-breeding samples from the more than 350 banana types originally collected by United Fruit scientists. It is a highly versatile fruit, suitable for cooking and eating; it has a slightly tart, apple-like flavor and is one of the few bred bananas to gain significant consumer acceptance.

The Goldfinger was created by Philip Rowe, a legendary advocate for traditional methods of banana breeding; Rowe died in 2002, and the program was taken over by Aguilar. Like Rowe, Aguilar believes that conventional hybridization—not genetic engineering—is the best way to devise a Cavendish replacement. The Goldfinger was evidence of that belief: It transported well and caught on in certain markets, notably Australia. But it didn't taste like the sweeter Cavendish and never took hold in the Americas.

Aguilar moves quickly through the fields surrounding the old Chiquita headquarters, chain-smoking Marlboros between

taking bites of sample fruit. He understands that to actually find the needle he's looking for in his vast yellow haystack, he's got to maintain a fast pace. But he also knows that agricultural husbandry is a slow process. It requires patience. To balance both, he says, it is necessary to see the job as something more than just ordinary science. The race to save the banana is personal. "The bananas," he says, "are my children."

Each of Aguilar's experimental varieties are tagged and set off in rows. To put the new bananas to the test, no fungicides are used here, so it isn't difficult to see the difference between healthy, resistant plants and afflicted ones. The strong plants have expansive green leaves. Both Panama disease and another malady, Black Sigatoka (which unlike Panama disease is present in Central America), cause leaves to wilt and crumble, leaving the fruit unprotected from the sun and reducing photo-

IS THIS YOUR NEW FAVORITE FRUIT?

The average American eats 150 Cavendish bananas each year. Hybridization has led to endless new varieties, although so far none effectively replicates our current top banana.



A



B



C



D

[A] The Ladyfinger Sweeter than the Cavendish, with a firmer texture, the three-inch-long Ladyfinger, Aguilar says, is arguably tastier. The problem: it's too low-yield to be viable in major markets.

[B] Prata Ana On first bite, there's sweetness, then a tart follow-up. This four-inch-long fruit is complex—it compares to the Cavendish the way a Belgian chocolate compares to a Hershey's Kiss. Aguilar says the fruit, which is popular in Brazil, is a good candidate for Cavendish replacement if the blight comes before a better choice can be developed.

[C] FHIA-17 This variety—so new that it's still unnamed—is bred from Gros Michel stock. It's a bit larger than today's supermarket banana and, Aguilar explains, has a "dilute" flavor: "If the Gros Michel is like straight whiskey, this tastes like it has a little water added."

[D] FHIA-26 One of the newest of Aguilar's hybrids, this fruit is about half the size of the Cavendish, though a bit thicker. It tastes intense and sweet, with a smooth, nearly creamy texture. But its drawback is immediately apparent: It has a very thin skin and thus won't travel well. —D.K.

IMPERFECT LEGACY An aging mural in Honduras





synthesis—the dying plant can't make sugar, and fruit yield is severely diminished. Sigatoka is a major problem, but, unlike Panama disease, it is controllable with chemical sprayings.

Bananas grow from an underground root structure; what juts out of the ground is more like a stem than a trunk. A long spike, covered in tiny flowers, emerges from the stem. The female flowers grow into fruit at the base of the flower-bearing stalk, while the male flower—bulbous and red—grows at the very tip of the stalk, weighing it down, curving toward the ground. The fruits grow in spiraling groups called “hands” (they're the bundles you buy in the store; an individual banana is called a “finger”). A banana plant can have up to a dozen attached hands; together, a plant's entire output is called a “bunch.”

Bananas are different from most other cultivated plants in that almost all the varieties—including the Cavendish—lack seeds (that round, dark center in a banana slice is the vestige of what was once the fruit's reproductive core). Cultivated bananas never reproduce sexually on their own. Rather, new stems grow from the existing

root, sometimes for many years. Forcing the pollen from one male flower to make its way to the female of another plant, however, is how traditional banana breeders like Aguilar's team develop new varieties. Most mornings, usually just as dawn is breaking, a team of hand pollinators pedal through FHIA's dirt-tracked fields on battered three-speed bicycles. They move from plant to plant, gathering the powdery pollen from the males and transferring it to receptive female flowers, keeping meticulous records of their activities (Aguilar calls the field “a giant spreadsheet”). The goal of all this is to get seeds, and to use them to grow Aguilar's experimental varieties, one of which, he hopes, will ultimately yield a tasty, market-friendly Cavendish replacement. What are the odds of an individual seed ultimately yielding a thriving hybrid? “About 1 in 10,000,” Aguilar says.

It takes about four months for a pollinated plant to bear fruit, which is harvested and brought to a processing shed for seed extraction. Workers press thousands of bananas through mesh strainers. About one seed is found for every 300 bananas. The seeds are then brought indoors, to what Aguilar calls the “embryo rescue unit.” Of the tiny number of seeds, only a third of them actually germinate. As the plants grow, they move from test tubes through a series of protected greenhouses and finally back to the fields. The first fruits are harvested two years after the initial pollination. “That's when we begin to get a sense of what we got,” Aguilar says. The difference between a near-natural banana and an FHIA hybrid can be significant. Aguilar shows me a series of photos dating back to 1959. The fruit yielded by Phil Rowe's earliest experiments in cross-breeding are very small. The descendants of those initial plants—the most recent is called FHIA-26—are massive and hardy.

Looking good is important for a consumer-friendly banana (Chiquita used to publish color charts that were hung in supermarkets, all designed to guide shoppers to the most yellow

bananas). But taste is equally critical. As Aguilar leads me through the fields, we pass row after well-delineated row of exotic bananas. He stops at a group of plants marked “Umpiko,” pulls a fruit off the stem, and peels it, taking a quick taste before handing a chunk to me. It's quite good—maybe milder-tasting than typical bananas—but the big problem with the Umpiko is that it ripens too fast. It would never make it to U.S. stores in time.

A few rows down, we duck into the shade of a low-slung plant.

Height, too, is key; the Gros Michel was so tall that it was susceptible to wind blow-down. The Cavendish is considerably lower and, therefore, hardier in bad weather, although in 1998 nearly the entire Honduran banana crop was still wiped out by Hurricane Mitch. Aguilar picks and tastes another banana.

None of our snacks are Cavendish, or descended from Cavendish—and none taste much like the banana I'm used to. Just as importers were afraid that consumers would reject today's most popular banana when it replaced the Big Mike,

they worry that a fruit that isn't creamy and sweet, like the Cavendish, will destroy markets. “We can make bananas that could be equal,” Aguilar says, “but not the same.”

Far from the steamy bananalands of the Caribbean, an entirely different effort to create the banana of the future nearly fills a basketball-court-size greenhouse 20 minutes east of Brussels, Belgium. Rony Swennen is director of the Laboratory of Tropical Crop Improvement at the Catholic University of Leuven. He oversees the world's largest collection of bananas and plantains. More than 1,200 varieties are kept in rows of test tubes, tiny plantlets encased in glass—each a potential donor of genetic material to be used in engineering new banana varieties. For the past decade, Swennen and his colleagues have been decoding and manipulating banana genes in the hopes of building resistance to the main afflictions that strike the fruit's commercial vari-

eties: Black Sigatoka; nematodes, a kind of minuscule worm; and the various strains of Panama disease.

Banana-bereft suburban breakfast tables notwithstanding, Swennen says that the real danger the spread of these pathogens poses is in the developing world, especially East Africa. In the densely populated countries around Lake Victoria—Uganda, Kenya, Tanzania, Burundi and Rwanda—bananas are primary nutrition, accounting for near-total carbohydrate consumption in some diets (in Uganda, the word for food, “matooke,” translates from Swahili as “banana”). The bananas eaten in East Africa are not the dessert-style fruit consumed in the West; they are far more versatile (there's even a beer brewed from bananas sold in Kampala). But like the Cavendish, African bananas are threatened. The Ugandan National Banana Research Program says that plants that once yielded fruit over a 50-year life span are now so much less resistant to disease that they become unproductive and require replacement after as few as five years. Bananas are also essential to the region's other crops: They provide cover for tropical forests, allowing staples such as beans and sweet potatoes to grow in their shade. Without (CONTINUED ON PAGE 104) ►

EIGHTY-TWO PERCENT OF U.K. SHOPPERS SAID THEY WOULD NEVER BUY A GENETICALLY ALTERED BANANA.

BANANA BANK
In the biotech facility near Brussels, banana-shoot tips are transferred into a vessel containing liquid nitrogen (1). The specimens are put in deep freeze at -196°C. The lab houses the world's largest collection of banana varieties—more than 1,200 species are stored in cool, low-light conditions (2) and sealed in plastic (3) until they're ready to be transported.

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The key to a proper wash and wax is in the details. It is of utmost importance to be prepared and to know the correct technique when washing and waxing your vehicle. If the proper procedure is not followed, then you will end up without a properly washed and waxed vehicle and everyone will be really disappointed. The truth of the matter is that the arduous yet **JUST**ifiable task of an all day wax and wash will be worth it. First, collect the numerous tools needed to complete your wash and wax. These include but are not limited to: sponges, dry towels, chamois, a bucket, a hose with spray nozzle attachment, wax, and an appropriate car wash detergent. You will also need a soiled car.

Directions are as follows: Squirt a couple of ounces of detergent in a bucket and fill it from the garden hose. In order to clean your sullied vehicle, **WET IT** first. It's important to spray the entire car down from top to bottom; removing as much of the caked on dirt as possible. Dip your sponge in the bucket and begin scrubbing the roof in a circular motion making sure to cover every inch with suds. After scrubbing the roof, move on to the rest of the car. Remember to scrub from the top down. Also, don't forget to always slide your trusty bucket along side you as you move along the car. After dunking the sponge in the nasty bucket several times you might want to refresh the solution. **WASH IT** out accomplishes two things. 1. Fresh water and detergent. 2. It will get rid of any dirt that has accumulated in the bottom of the bucket. If you're not careful, dirt could end up in your sponge and may scratch the finish of your car. Now that we have scrubbed the car, spray the rest of the soap off and quickly get ready to dry. Towel handy? Great, you're prepared. Start at the top of the car and work down. Gently wipe **&** dry the entire car. This will keep you from having pesky water spots when the job is done. Don't forget those mirrors and windows. Great, we're half way there.

Let's start waxing this puppy. Now, dry and clean, your vehicle's finish is ready to accept a fresh shine. Apply the wax to your car using a fresh terry cloth towel in a circular motion. Once you've given that babe a good massage, wait a while on the **WAX IT** will **DRY** before dusk. When buffing off the wax, stroke the car firmly so no residual wax remains. With your car shining pretty consider moving on to the interior. But that can wait for another day. Now you've got a proper wash & wax, and the exhaustion to prove it.



*The **SIMPLE** way to get a wax with every wash.*



THE POPSCI BUYER'S GUIDE: CARS

Should you get a turbocharged four or a high-tech hybrid? A slick seven-speed automatic or a sequential manual? Will all-wheel drive really save your butt? You probably already know what type of vehicle you want—SUV, sedan, sports car—but understanding key automotive technologies in today's cars can help you decide among competing models. Here, we dissect the critical innovations manufacturers are offering to enhance performance, safety or both.

BY ERIC ADAMS | JOE BROWN | PRESTON LERNER
MICHAEL MOYER | MATTHEW PHENIX | STEPHAN WILKINSON

PHOTOGRAPH BY MICHAEL KRAUS
VEHICLE PHOTOGRAPHY BY JOHN B. CARNETT

» POWER TO GO | ENGINES

Don't let the showroom jargon scare you. The internal combustion engine still works as it always has; it's just better. Modern refinements can make a huge difference in initial cost as well as operating cost, raising or lowering either, but they also greatly improve performance. Depending on the specific model and price, engines may have any of several enhancements—these are the four you should know about.

1



VARIABLE DISPLACEMENT

•**Tech** To improve gas mileage at highway speeds, certain engines can now deactivate half their cylinders—or just two. While the pistons continue to move inside the cylinders, fuel intake is shut off.

•**Pacesetter** Honda Odyssey. The sophisticated 255-horsepower 3.5-liter V6 in the Odyssey smoothly shuts down three of its six cylinders during highway cruising and deceleration, bumping up mileage by as much as 12 percent.

•**Other options** Variable displacement works in muscle cars, too. The Dodge Magnum RT's 340hp, 5.7-liter V8—as well as other Dodge and Chrysler Hemi engines—features a multi-displacement system that boosts fuel economy by 5 to 20 percent.

•**Bottom line** Although the engines are prone to subtle audible variations between full and partial-displacement use, it's barely noticeable. Honda, in fact, has equipped its benchmark van with noise-canceling technology, piped through the car's stereo, to effectively mask any evidence of the system.

Honda Odyssey

POWER 255 hp, 250 lb.-ft. of torque, V6

PERFORMANCE 0–60 in 8.6 sec., 117 mph top speed

PRICE \$34,700 (touring version)

2

HYBRIDS

•**Tech** To stretch fuel economy, true gas/electric hybrids run either with both the gas engine and the electric motor working in a partnership of varying power ratios, or on electric power alone. “Mild hybrids,” on the other hand, supplement gas engines with electric motors—adding horsepower without sacrificing fuel economy—but they can't run on electricity alone.

•**Pacesetter** Lexus RX 400h. Using parent company Toyota's technology, this true hybrid SUV combines a 3.3-liter gasoline V6 and a pair of electric motors. Its 268 hp and 212 pound-feet of torque thrust it to 60 mph in 7.3 seconds—half a second faster than its conventional sibling, the RX 330—while its fuel efficiency is a combined 29 mpg city/highway, a 38 percent improvement.

•**Other options** The Honda Accord Hybrid gets a terrific boost from its electric motor, but test-drive it first—our sample vibrated slightly during engine shutdowns at stoplights.

•**Bottom line** Most hybrid drivers are finding their real-world fuel economy to be lower than the Environmental Protection Agency estimates, which are based on outdated testing methods. Remember that hybrid efficiencies are greatest in urban driving—highway mileage is only slightly better.



Lexus RX 400h

POWER 268 hp, 212 lb.-ft. of torque, combined V6 and electric motors

PERFORMANCE 0–60 in 7.3 sec., 124 mph top speed

PRICE \$49,200

» SPECS

HORSEPOWER VERSUS TORQUE

How many cylinders do you need?

For basic fuel efficiency, four-cylinder engines rule. But for real acceleration and easy cruising at high speed, get a turbocharged four, a six-cylinder or an eight. And a Hyundai V6 is nothing like an Audi V6—the simpler (and cheaper) 3.5-liter engine in Hyundai's XG350 produces 194 horses, while the 3.2-liter power plant in the Audi A6 employs sophisticated engine-management systems to help generate 255 horsepower. In any case, you can stop at a V8—there are a handful of cars with V12s being sold in America, but there's little they can do that a well-engineered V8 can't, except make outrageous howling noises and gulp gas like it's shooting out of a garden hose.

3

TURBOCHARGING

•**Tech** Using exhaust-driven fans—turbos—to compress air and force it into an engine generates a greater explosion inside the cylinder and, thus, more power. It's an easy, inexpensive way to goose both small and large engines' performance.

•**Pacesetter** Mitsubishi Lancer Evolution IX. For the ninth iteration of its hallowed Evo—a featherweight, all-wheel-drive sedan revered by rally fans and street racers—Mitsubishi squeezed another 10 hp out of the 2.0-liter inline four-cylinder engine, thanks largely to an innovative twin-scroll turbocharger that generates 20.1 psi of pressure inside the cylinders. The result is an astonishing 286 horsepower at 6,500 rpm, and 289 pound-feet of torque.

•**Other options** The Porsche Cayenne Turbo's V8 gets a turbo boost from 340hp to 450 hp, making it the world's fastest SUV.

•**Bottom line** For a performance car, natural aspiration remains the gold standard, because you have much faster and more linear engine response. But turbocharging is no slouch—turbo lag is mostly unnoticeable now, and manufacturers such as Audi, Porsche and Saab routinely turbocharge their lineups with impressive results.



Mitsubishi Lancer Evolution IX

POWER 286 hp, 289 lb.-ft. of torque, inline 4-cylinder

PERFORMANCE 0–60 in 4.4 sec., top speed unavailable

PRICE Not set at press time

4

VARIABLE VALVE TIMING



•**Tech** Computer-controlled variable valve timing (VVT) smoothes out engine performance by optimizing the fuel and air mixture inside the cylinders at different engine speeds. Systems vary, but typically, at higher speeds, the intake valves open earlier, wider and for longer durations, delivering maximum fuel and air for increased power. At lower rpm, the overabundance of gas would be wasted and cause a rough idle, so the valves admit less.

•**Pacesetter** Ford Mustang GT. Its all-aluminum, 4.6-liter V8 employs a variable cam timing system that increases fuel efficiency, lowers exhaust emissions, and generates a robust power output of 300 hp and 320 lb.-ft. of torque.

•**Other options** Most Hondas—the company that pioneered VVT—Toyotas and Nissans now feature VVT, as do many performance cars.

•**Bottom line** This technology is a tremendous leap forward and is worth seeking out. Ford's version is one of the simplest yet, making it an affordable option for carmakers and, ultimately, more accessible to consumers.

Ford Mustang GT

POWER 300 hp, 320 lb.-ft. of torque, V8

PERFORMANCE 0–60 in 5.1 sec.,

147 mph top speed

PRICE \$25,200

We all drool over horsepower figures, but what is often more relevant is torque—how much force the car applies to the road. Horsepower helps maintain speed (high-horsepower engines really strut their stuff at triple-digit speeds), but torque determines whether the car can accelerate with gut-churning ferocity. The Mercedes E500 and Acura RL both have 300hp, but the V8 Merc has 339 pound-feet of torque, and a 5.8-second 0–60 time, while the V6 RL musters only 260 lb.-ft. of torque and a 6.6-second 0–60.

» HANDLING THE ROAD | BRAKING AND TRACTION

Air bags, seat belts and crumple zones may save your life in an accident, but better to avoid the need for them altogether. Antilock-brake system (ABS) technology has paved the way for new safety innovations that help you maintain control in cornering situations where conventional brakes would stop the wheels but not necessarily the car. The ABS wheel-speed sensor is a critical part of traction control, electronic stability-control and certain all-wheel-drive systems, all of which help your vehicle stay on its intended path.

1 TRACTION CONTROL

- Tech** Traction control uses the ABS sensors to determine when a wheel's rotational speed is out of sync with the engine's revs or the other wheels—when the wheel spins in wet or icy conditions or when accelerating—then selectively brakes the wheel and reduces power to it.
- Pacesetter** Dodge Charger. The new, sub-\$25,000 Charger demonstrates how traction control is now available across the price spectrum. The sharply styled sedan comes standard with a system developed by

corporate cousin Mercedes-Benz.
•**Other options** The Cadillac DTS puts 291 horsepower to the pavement through its front wheels. Traction control moderates power so that the driver isn't constantly muscling the front wheels straight.

•**Bottom line** Some enthusiast drivers think traction control diminishes road feel and interferes with the car's performance. But no need to worry—manufacturers often include buttons to desensitize the systems.

2 MULTIFUNCTION BRAKES

- Tech** Disc brakes, which use hydraulic calipers to clamp down on rotors attached to the wheels, are quickly moving well beyond their now almost basic ABS systems.
- Pacesetter** BMW 330i. The redesigned 3 Series includes several innovative brake features, among them Brake Standby, which anticipates hard braking and snugs the pads closer to the rotors, and Start-Off Assistant, which holds the brakes to prevent rollback when starting

uphill from a complete stop.
•**Other options** The Mercedes S-Class vehicles feature an electronic braking system, Sensotronic, that applies brake force to each wheel independently, helping retain control during panic stops, even on

bumpy roads. Although it suffered early technical problems, the system has matured.
•**Bottom line** At the very least, try to avoid any car that doesn't have antilock brakes—you can't afford *not* to have them.

3 ALL-WHEEL DRIVE

- Tech** If road conditions cause any of a car's wheels to slip, advanced AWD systems automatically divert power to the wheels that have grip. Working in concert with traction-control systems and limited-slip differentials, these systems shift torque front-to-rear and, in some cars, side-to-side to help maintain control.
- Pacesetter** Infiniti M35. Unlike other AWD systems, Infiniti's version maintains a rearward bias for a satisfying rear-drive feel. In adverse con-

ditions, though, it behaves like other systems.
•**Other options** The German manufacturers have been pushing all-wheel drive for a long time. Most Mercedes and Audis offer it, and Porsche's 911 Carrera 4

makes excellent use of it as a performance enhancement.
•**Bottom line** In general, the systems add weight and cost, and they probably *aren't* necessary for moderately powered cars driven in states that don't see much snow.

4 ELECTRONIC STABILITY SYSTEMS

- Tech** Electronic stability systems moderate engine power and selectively apply brakes to individual wheels to stop cars from sliding out of control. Sensors compare wheel speed and steering angle to the vehicle's rotation around its vertical axis to determine whether the car is moving in the direction the driver intends.
- Pacesetter** Porsche Boxster. The stellar Porsche Stability Management system counters wheel slippage prompted by drivers who lift the throttle

abruptly during cornering—which can cause the back end to slide out—by subtly applying the gas to prevent a slide or spin.
•**Other options** The Mini Cooper S Works comes standard with electronic stability control. This 201hp,

2,678-pound car would be prone to spins during aggressive driving if the system weren't in place.
•**Bottom line** These systems don't differ much—except in how they're calibrated—so you can be happy just knowing your car has it.

All-Wheel-Drive Myths

All-wheel-drive systems are not panaceas for all driving conditions. The systems have limited, though important, usefulness. AWD is good in two situations: under acceleration in snow or mud, where it's priceless; and in high-performance driving, again under positive torque. Unless you drive very aggressively in slippery conditions, AWD doesn't help in the rain. When you back out of the throttle, it does nothing. It doesn't increase cornering limits or decrease braking distances. All-wheel-drive cars are safer, however, because they recover better in understeer situations and can take advantage of electronic stability control, since the speed of all four wheels can be computer-regulated via the brake, throttle or both.

Dodge Charger

POWER 250hp, 250 lb.-ft. of torque, V6

PERFORMANCE 0-60 in 6.0 sec.,
130 mph top speed

PRICE \$23,000



BMW 330i

POWER 255 hp, 220 lb.-ft. of torque,
inline 6-cylinder

PERFORMANCE 0-60 in 6.1 sec., 155 mph top speed

PRICE \$37,000



Infiniti M35

POWER 280 hp, 270 lb.-ft. of torque, V6

PERFORMANCE 0-60 in 6.0 sec.,
top speed not available

PRICE \$42,600



Porsche Boxster

POWER 240 hp, 199 lb.-ft. of torque, flat-6

PERFORMANCE 0-60 in 6.2 sec.,
159 mph top speed

PRICE \$43,800

Porsche Boxster



» MANAGING POWER | TRANSMISSIONS

The manual transmission as we know it—a shifter on the floor and a clutch pedal—is suffering through its death throes. Its competitors? New seven-speed automatics, which improve acceleration over more sluggish versions and adjust shift points to maximize performance; continuously variable transmissions that enhance the power of small engines; and semi-automatic systems that offer the thrill and control of manuals with the ease, when needed, of fully automatic operation.

SEQUENTIAL MANUALS

•**Tech** Standard equipment in Formula One cars because of their superhuman shift speeds, sequential manual transmissions—which use paddle shifters and an electrohydraulically controlled clutch (no foot pedal)—are now appearing in road-going performance cars.

•**Pacesetter** BMW M3. BMW offers its Sequential Manual Gearbox on its M3 for lightning-quick engagement of its six gears, with several selectable shift programs that allow you to change its demeanor—from easygoing to race-ready.

•**Other options** True sequential manuals are few and far between outside the realm of supercars. The one in the new, \$200,000 Ferrari F430 is, well, *recommended*.

•**Bottom line** Don't mistake a manumatic for a sequential manual. Those allow you to shift an automatic transmission at will; an SMG is a manual at heart, complete with robust cogs and a clutch instead of the torque converters and planetary gears found in automatics. These truly are the future of performance driving.



BMW M3

POWER 333 hp, 262 lb.-ft. of torque, inline-6 cylinder

PERFORMANCE 0–60 in 4.8 sec., 155 mph top speed

PRICE \$50,400

AUTOMATICS

•**Tech** Automatic transmissions adjust gear ratios as the car speeds up, so the engine can work at the optimum speed for the task at hand—high revs for power and acceleration, low revs for economy. Better automatics have more gears and adaptive “shift maps” that adjust based on whether you're driving vigorously or just cruising around.

•**Pacesetter** Mercedes E350. Mercedes's 7G-Tronic seven-speed automatic helps improve acceleration by adding shift points—via the additional gears—to give more precise control over how power is applied.

•**Other options** The Range Rover Sport's transmission is calibrated for both off-road and sporty on-road driving—for example, it won't upshift if the car is being driven hard through corners.

•**Bottom Line** Ultimately, more gears are better. Each new gear helps to more efficiently put power to the pavement, providing more precise control over the relation between the vehicle speed and the engine speed.



Mercedes E350

POWER 268 hp, 258 lb.-ft. of torque, V6

PERFORMANCE 0–60 in 6.5 sec., 130 mph top speed

PRICE \$50,800



1. Offroad power from Dodge



2. GMC's monster diesel



3. Next-gen Miata



4. Caddy's theater-on-wheels

POPSCI ON THE WEB

Read in-depth car reviews and learn the truth about buying wheels and tires, choosing gasoline, and getting your oil changed at www.popski.com/autobuyersguide. Also: killer off-roaders (1), high-torque diesels (2), new small convertibles (3) and in-car entertainment systems (4).

2

CONTINUOUSLY VARIABLE TRANSMISSION



Ford Freestyle

POWER 203 hp, 207 lb.-ft. of torque, V6

PERFORMANCE 0-60 in 8.2 sec., 111 mph top speed

PRICE \$27,500

•**Tech** A continuously variable transmission (CVT) uses a moving pulley system and a belt or chain to infinitely adjust the gear ratio across a wide range and transfer power between the engine and the wheels.

•**Pacesetter** Ford Freestyle. The CVT helps make the most of the Freestyle's modest 203 horsepower at all speeds and loads and deliver a respectable combined 22 mpg.

•**Other options** Most hybrids, including the Lexus RX 400h and the Ford Escape Hybrid, use CVTs because their gasoline-engine components are generally smaller than they would be in nonhybrid cars of the same size, making the CVT's ability to keep an engine in its sweet spot particularly useful.

•**Bottom line** CVTs can't yet handle the high torque demands of performance cars. Some people are put off by the incessant "waaaaa" of a CVT that remains at a constant rpm during acceleration and doesn't give the aural cues they're used to as the car increases speed.

4

DUAL CLUTCH



Audi A3

POWER 200 hp, 207 lb.-ft. of torque, inline 4 cylinder

PERFORMANCE 0-60 in 6.7 sec., 130 mph top speed

PRICE \$25,460

•**Tech** A variation on the sequential manual gearbox, this technology—currently available only on Audi and Volkswagen production cars—uses a pair of clutches to cycle through gears, prompted by the computer or the driver, via steering-wheel-mounted paddle shifters. Each gear change takes just two tenths of a second, with no interruption of the torque flow.

•**Pacesetter** Audi A3. The Direct-Shift Gearbox (DSG) is standard in the forthcoming V6 version of the A3 Quattro—a testament to the new technology's excellent performance.

•**Other options** The DSG transmission is also available in Audi's sports car, the TT, and the Volkswagen Beetle turbo diesel.

•**Bottom line** On the road, the DSG shifts noticeably faster and more smoothly than conventional automatics, making for much more spirited driving. If high-speed shifting isn't appealing, you can order the 2.0-liter A3 with a conventional stick shift.

» INFORMATION ACCESS | DRIVER INTERFACES

Conveying information to the driver efficiently and without distraction is, evidently, an extreme challenge for automobile manufacturers. They've all struggled with everything from logically organizing instrument displays and controls to making functions on the new LCDs easily accessible. The systems have improved substantially, and manufacturers now offer navigation, entertainment and vehicle-systems controls that are intuitive and easily navigable.



Audi A6
POWER 335 hp, 310 lb.-ft. of torque, V8
PERFORMANCE 0–60 in 6.0 sec., 130 mph top speed
PRICE \$52,220

VEHICLE-SYSTEMS INTERFACE

• **Tech** Screen-based interfaces allow drivers to control audio and navigation functions, climate, and even suspension settings.
• **Pacesetter** Audi A6. Audi has mastered this art. The elegant Multi Media Interface allows the driver to oversee vehicle systems without a dizzying array of buttons or a maddening hierarchy of menus

and submenus. A second, smaller information screen sits between the speedometer and the tachometer for easy reference while driving.
• **Other options** Many Japanese systems, such as those found in the luxury Lexus and Acura lines, are almost as good as the Audi's, but the American manufacturers often have unwieldy, unintuitive systems

that are more distraction than true driver aid.

• **Bottom line** The best displays are high up, near the driver's line of sight, with controls positioned between the two front seats. Steer clear of poorly laid-out radio controls. Fortunately, many controls are migrating to the steering wheel, where they should be.

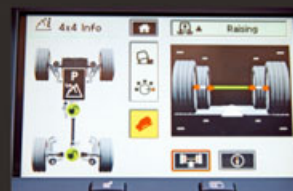


FUNCTION-SPECIFIC SYSTEMS



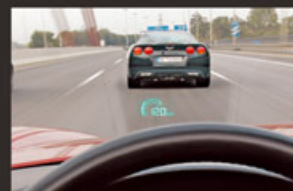
Land Rover LR3

Off-Road Information Screen Stuck in a rut? If you don't know what your wheels are doing, it can be awfully hard to get out. The Land Rover LR3's color touchscreen tells you, among other things, the steering angle, whether a wheel is off the ground, and how the differentials are set. **\$50,000**



Chevrolet Corvette

Head-Up Display It's fighter-jet technology for the street. The head-up display for the Chevrolet Corvette, a 186mph hot rod, features a floating field of data, projected on the windshield just above the dashboard, that might otherwise draw eyes from the road. It includes speed, revs, fuel level, even cornering forces. **\$48,900**



Ford Escape Hybrid

Hybrid Management Screen Drivers can maximize the efficiency of their hybrids by adjusting their driving style. The Ford Escape Hybrid has an LCD with a real-time "power path" offering graphic indicators of fuel consumption, battery charge levels, and how the motors are working together. **\$28,600**





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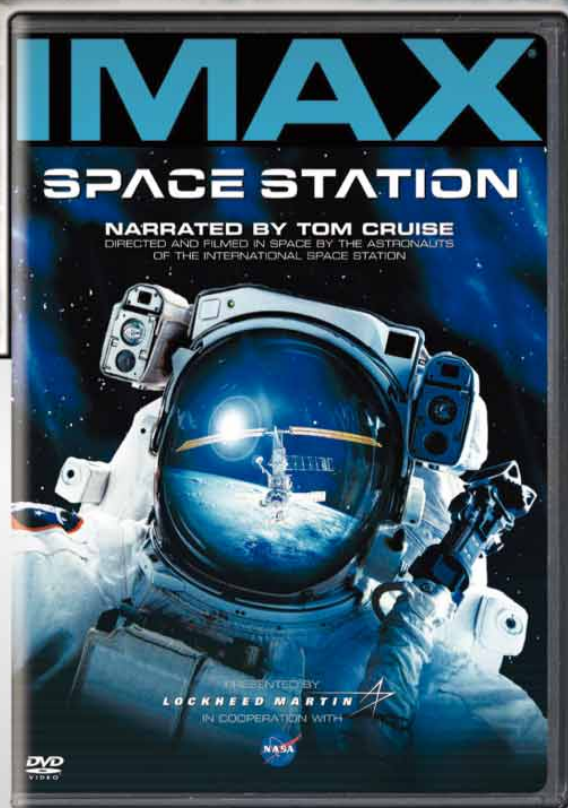
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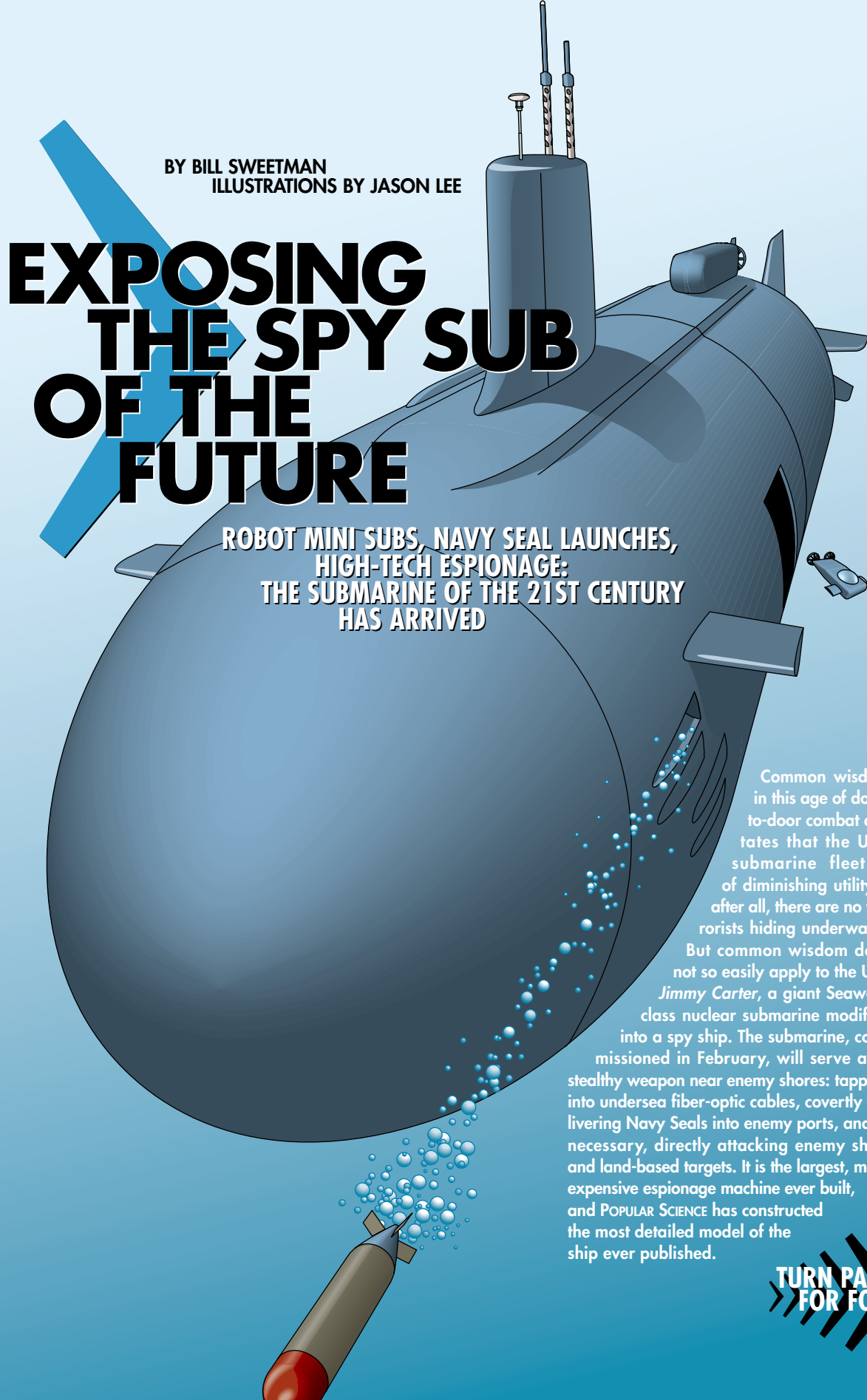
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BY BILL SWEETMAN
ILLUSTRATIONS BY JASON LEE

EXPOSING THE SPY SUB OF THE FUTURE

ROBOT MINI SUBS, NAVY SEAL LAUNCHES,
HIGH-TECH ESPIONAGE:
THE SUBMARINE OF THE 21ST CENTURY
HAS ARRIVED

Common wisdom in this age of door-to-door combat dictates that the U.S. submarine fleet is of diminishing utility—after all, there are no terrorists hiding underwater. But common wisdom does not so easily apply to the USS *Jimmy Carter*, a giant Seawolf-class nuclear submarine modified into a spy ship. The submarine, commissioned in February, will serve as a stealthy weapon near enemy shores: tapping into undersea fiber-optic cables, covertly delivering Navy Seals into enemy ports, and, if necessary, directly attacking enemy ships and land-based targets. It is the largest, most expensive espionage machine ever built, and POPULAR SCIENCE has constructed the most detailed model of the ship ever published.

TURN PAGE
FOR FOLDOUT

Do Nikon owners have greener summers?

Or does it just look that way? Introducing the Nikon® D50™, an affordable, easy-to-use digital SLR. At the heart of the D50 is *Nikon's Exclusive Feature System*, making it easier than ever to take digital pictures with breathtaking vividness and detail. It starts with Nikkor® lenses for unrivaled color, clarity and contrast. And the Nikon D50 allows you the versatility of choosing any AF Nikkor lens depending on your shooting needs. The Nikon D50, just \$899.95 MSRP with lens. Want to take digital pictures that do summer justice? Visit nikondigital.com.



The New D50 Digital SLR

SPY ANATOMY

The USS *Jimmy Carter* is one of the Navy's three Seawolf-class subs—the largest, fastest and most heavily armed in the fleet—with a billion dollars' worth of modifications tacked on. Most of these, such as new launching systems for pilotless aircraft, a super-stealthy jet-propeller design and the first-ever “wasp waist,” will help the craft carry out its primary mission: espionage.

SUPER SONAR

You may not hear the *Carter*, but with the help of a 30-foot golfball-like array of microphones mounted in the bow, it can hear you. Other arrays mounted in the ship's sides will help the *Carter* quickly triangulate the source of a sound.

Microphone array

CARTER AT A GLANCE

Size 453 by 40 feet

Weight 12,190 tons

Power plant General Electric S6W nuclear reactor that powers dual steam turbines

Cruising speed 35 knots (est.)

Max. depth 2,000 feet (est.)

Crew 140

Cost \$3.2 billion

Namesake The only U.S. president to have been a submariner

Capsule launcher

LAUNCHING AERIAL

The masts on a sub's sophisticated video and cameras, but they can't see the horizon. Solution: single-use unmanned (UAV), packed in a capsule with wings folded, from a capsule at the wasp waist. As the sub rises to the surface, it launches the capsule with a built-in catapult.

Missile launch tubes

Torpedo tubes

INTERNET AT SEA

Cold War submarines used to be silent, seldom transmitting except in an emergency, but silence doesn't work when a mission requires the submarine's time-sensitive intelligence. The *Carter's* miniature satellite-communication antennas can pump beams of data to spacecraft overhead yet are small enough to fit on the top of the submarine's extending masts. The sub can also trail an antenna hundreds of feet behind it so as to better hide its true position.

AIR SPIES

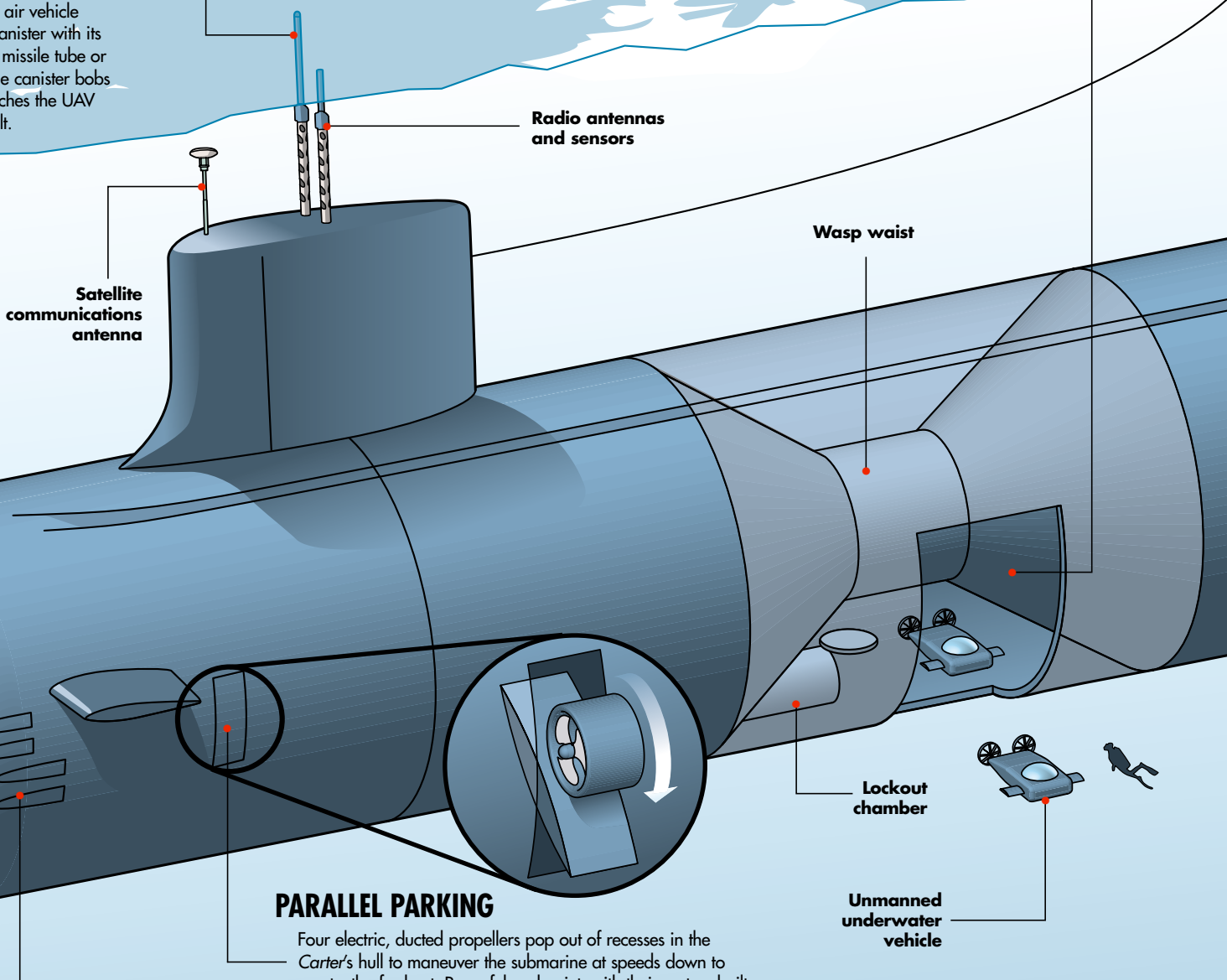
can carry and infrared can't see beyond Launch a small air vehicle canister with its missile tube or the canister bobsches the UAV it.

Towed satellite antenna

UNDERWATER GARAGE DOOR

Just behind the mast, the *Carter's* watertight pressure hull shrinks to a narrow walkway. The space between this tunnel and the smooth outer hull fills with water, and big sliding hatches open the space to the ocean. This unique "wasp waist" section lets the crew launch and recover objects that are larger than a standard 21-inch torpedo tube using a lockout chamber to connect the boat's interior to open water.

The Navy isn't saying exactly how it will be used, but payloads are likely to include unmanned underwater vehicles and Seal raiding craft.

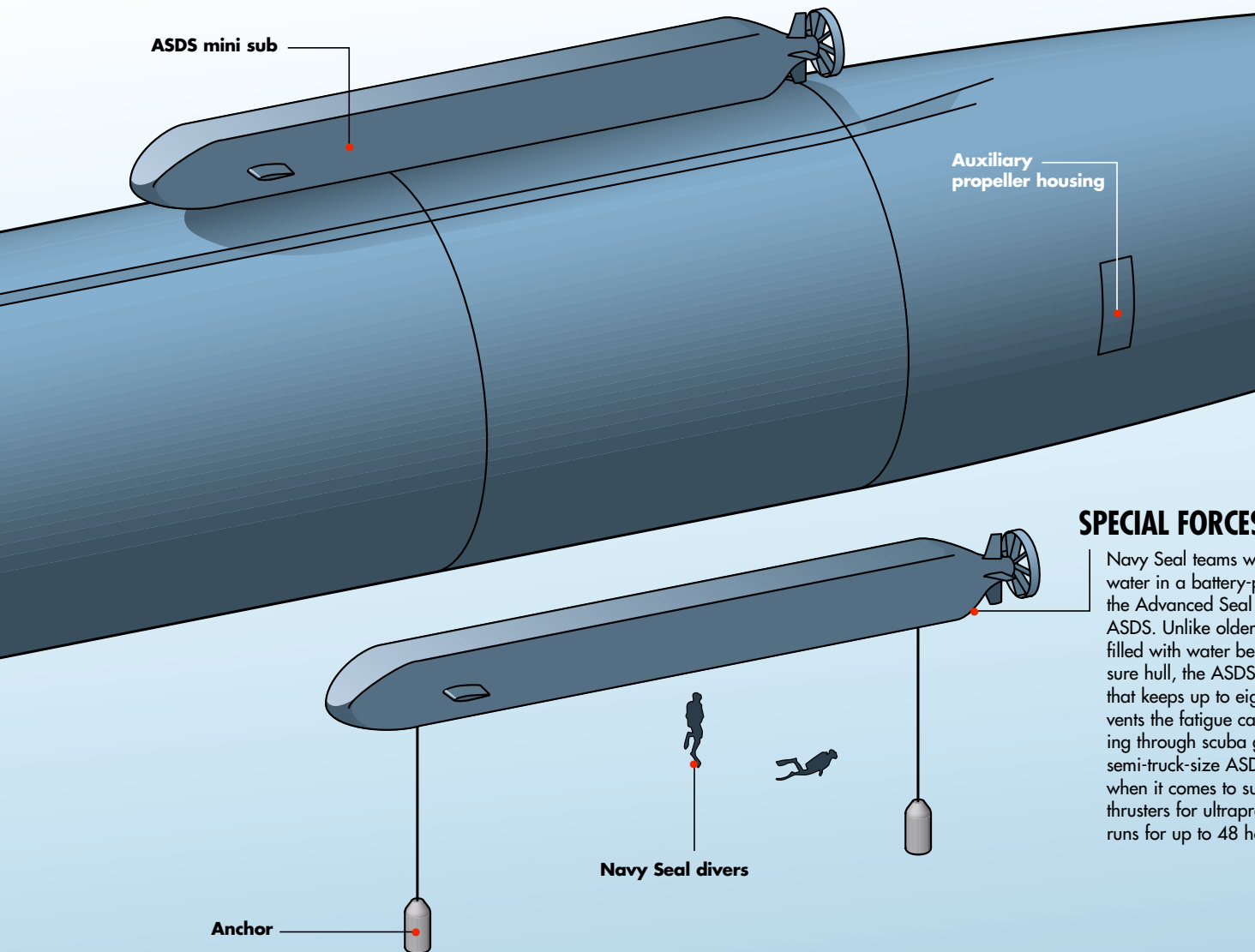
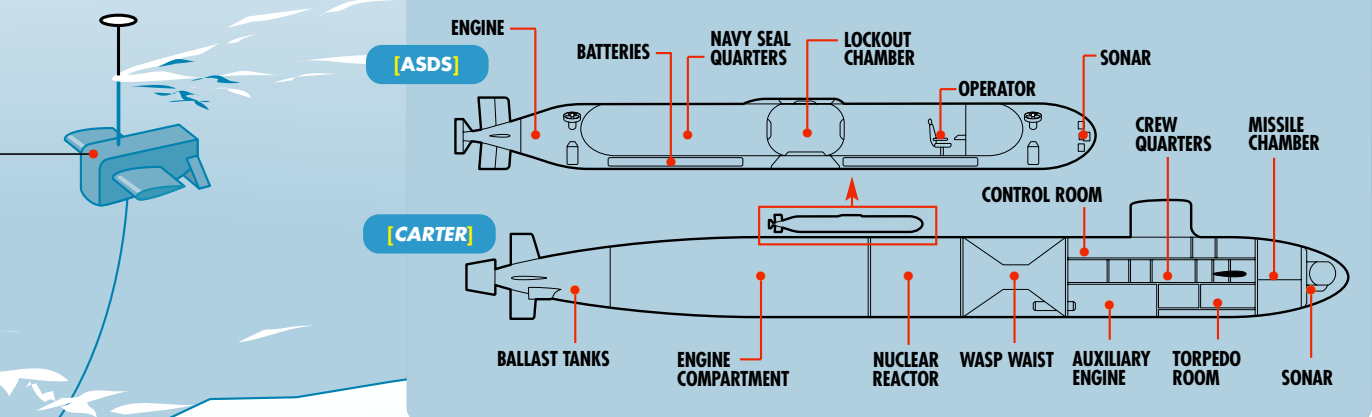


PARALLEL PARKING

Four electric, ducted propellers pop out of recesses in the *Carter's* hull to maneuver the submarine at speeds down to one tenth of a knot. Powerful and quiet, with their motors built into their impeller rims, the maneuvering propellers can even spin the massive boat around its own axis.

Inside the Ships

The *Carter* shares its basic layout with *Seawolf*-class subs, with the 100-foot-long wasp waist added during its four-year renovation. The *ASDS* is the first mini sub to include a lockout chamber to keep Navy SEALs dry.



SPECIAL FORCES

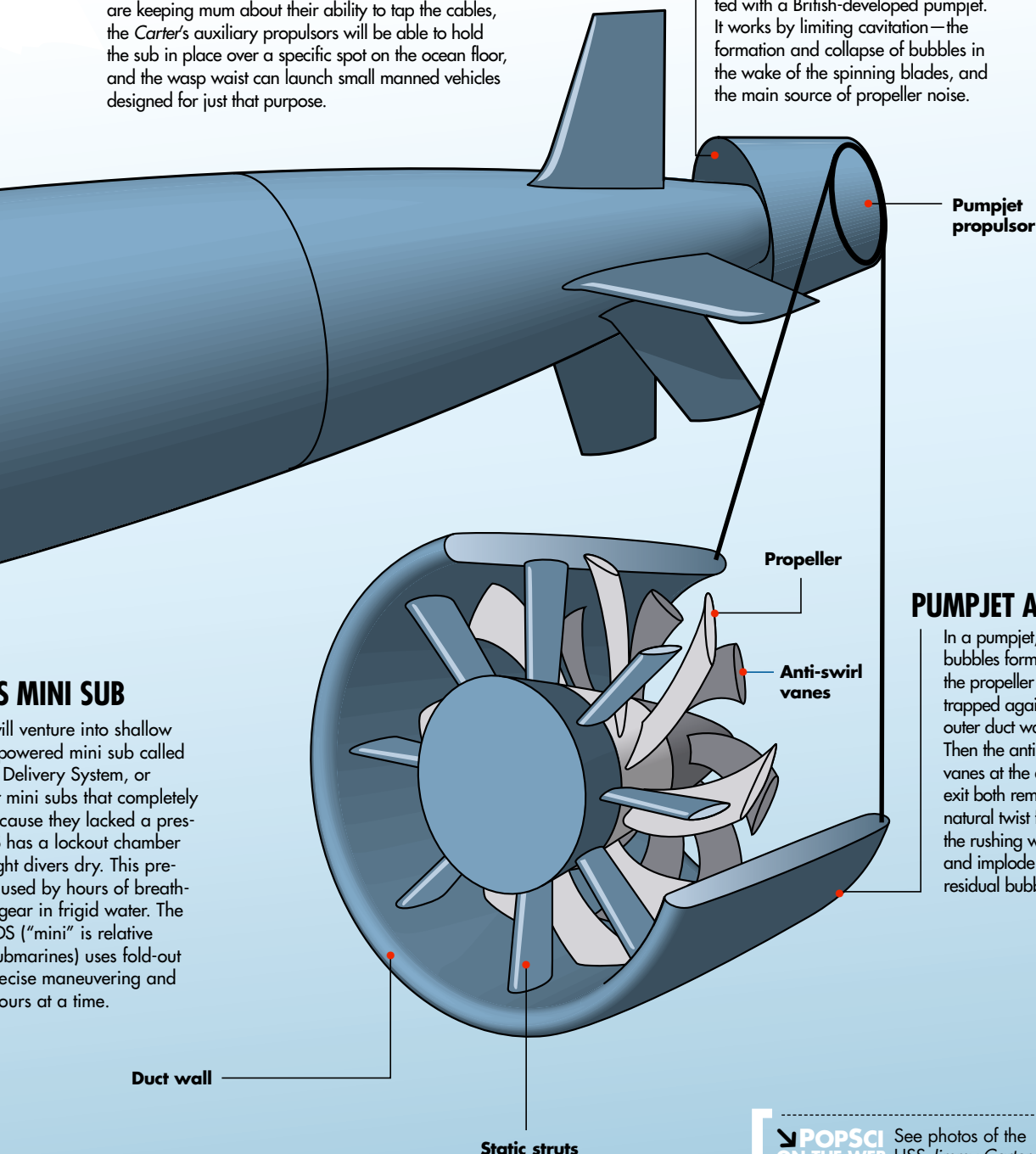
Navy Seal teams work in water in a battery-powered sub called the Advanced SEAL Delivery System (ASDS). Unlike older mini subs, the ASDS is a pressure hull, the ASDS is a pressure hull that keeps up to eight SEALs dry. It prevents the fatigue caused by breathing through scuba gear. The semi-truck-size ASDS is used when it comes to surface operations. It has thrusters for ultrasonic navigation and runs for up to 48 hours.

HOW TO SPY FROM A SUBMARINE

The *Carter's* myriad innovations will be used for highly specific combat functions. The ASDS mini sub it carries will be able to maneuver undetected into enemy ports, releasing its cargo of Navy SEALs onto a boatyard or shore. The *Carter's* encapsulated unmanned air vehicles will be able to investigate enemy targets out of range of conventional UAV launches. And its UAVs will be able to perform reconnaissance in spaces submarines can't reach. But perhaps its most intriguing ability—and certainly its most secret—will involve tapping the under-sea fiber-optic cables that carry most of the world's data. Although the Navy and the National Security Agency are keeping mum about their ability to tap the cables, the *Carter's* auxiliary propulsors will be able to hold the sub in place over a specific spot on the ocean floor, and the wasp waist can launch small manned vehicles designed for just that purpose.

SILENT RUNNER

Submarines survive by stealth, and nothing can make as much noise as 52,000 horsepower delivered through the propeller. That's why the details of propeller technology are a closely guarded secret. Photos show, however, that the *Carter* has been fitted with a British-developed pumpjet. It works by limiting cavitation—the formation and collapse of bubbles in the wake of the spinning blades, and the main source of propeller noise.



MINI SUB

will venture into shallow powered mini sub called Delivery System, or mini subs that completely cause they lacked a pres- has a lockout chamber ght divers dry. This pre- used by hours of breath- gear in frigid water. The OS ("mini" is relative submarines) uses fold-out ecise maneuvering and ours at a time.

PUMPJET AT WORK

In a pumpjet, any bubbles formed by the propeller are trapped against the outer duct wall. Then the anti-swirl vanes at the duct exit both remove the natural twist from the rushing water and implode any residual bubbles.

➤ **POPSCI** See photos of the
ON THE WEB USS *Jimmy Carter*
cruising at sea at popsci.com/carter.



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DEPT: **GEEK GUIDE**

INVESTIGATOR: **NIGEL POWELL**

TECH: DIY Internet radio

COST: Free–\$2,850

TIME: 10 minutes
and up

DABBLER ■■■■■ MASTER

Wanna Be a DJ?

Stream a few songs to friends or be the next shock jock—here's how to let loose your inner Johnny Fever

It doesn't have to be this way: Sitting there night after night, listlessly turning the radio dial trying to find something, anything, decent to listen to. Unchain yourself from the Clear Channel melody, the droning clones playing Justin and Jay-Z three times an hour. Nowadays you—yes, you—can provide something better. All you need is a computer and an Internet connection, and you can beam your own soundtrack to the world. Stop searching for the radio station you've always dreamed of, and go make it yourself.

According to online-audience trackers Arbitron and Edison Media Research, Internet radio is rapidly becoming a major part of the country's entertainment habit. In one March week alone, more than nine million Americans tuned in to the thousands of Web stations broadcasting music and chat. Webcasting—transmitting multimedia content over the Internet—is not new, but the broadband explosion has spurred the development of a vast range of tools allowing wannabe DJs to create, organize, and deliver programming to anyone who will listen. At the low end are basic free programs such as MP3Mystic (mp3mystic.com), which lets you stream songs to an audience of one. At the top are full-blown studio systems like the \$2,850 WorldVibrations device (worldvibrations.com)—an Internet radio station in a box. These expensive solutions offer better-quality audio, fully automated programming and announcements, and advertisement- and program-guide creators all rolled into one. In between, there are tools for all levels of amateur DJs. Turn the page to learn how to start your own superstation. >>>

OLIVER WOLFSON

5 THINGS...

YOU DIDN'T KNOW YOU COULD **CUSTOMIZE ONLINE**

1 CHUCKS, VANS AND NIKES

Converse.com lets you choose the color for each panel of your Chuck Taylor All Stars (high- or low-top), and Vans.com does the same for its classic models. But at NikeiD.com, you can customize any one of 27 sneaker styles, as well as gym bags, watches and golf balls.

2 MINI COOPERS

Mini's build-your-own site (miniusa.com) offers seemingly infinite interior and exterior options (map light? JCW tuning kit?) for tricking out one of four Cooper models. Save your dream machine as a desktop image, print a PDF brochure, and even order it from a dealer.

3 YOUR GARDEN

With the BBC's Virtual Garden (bbc.co.uk/gardening), you can construct and move through a rendered 3-D model of your own space, complete with decking and fences. Fill it with any of dozens of flowers and trees, then add a bench, fountain or grill. When you're done planning, print a list of your chosen flora to take to the nursery.

4 POSTAGE STAMPS

Personalize your mail by creating stamps that bear your own photos at photo.stamps.com. Upload your shot, rotate or re-crop it, and order at least one sheet of 20 stamps (\$17 for standard 37-cent postage).

5 A BARREL OF WINE

San Francisco winery Crushpad (crushpadwine.com) lets you be the winemaker. Work with their pros to make 30 key decisions, including what varietal to use; when to press; and whether to de-stem, crush, or both. Just don't screw up—the minimum order is 300 bottles, at \$13 to \$20 per bottle. —MIKE HANEY

TWO WAYS TO WEBCAST



TO A FEW FRIENDS

Before you start scripting bits and booking guests, decide how big an audience you'd like to reach. If it's small—say, 10 friends—you can use software that relies on your own broadband connection to deliver the tunes; but add too many listeners, and the audio quality will

suffer. Shoutcast (shoutcast.com) is the most popular free service, although setup is not for novices. You'll need to download the Winamp MP3 player, a software plug-in called Shoutcast Source and a software server called ShoutcastDNAS (find links to instructions at popsci.com/h20). Once installed, simply hit Play, switch on the broadcast module, and your audio will be available to anyone browsing the station listings at shoutcast.com. Newcomer Mercora (mercora.com) offers a similar service that uses a proprietary player and sets restrictions on the amount of material your listeners can access each day to keep you from violating copyright laws.

(Shoutcast leaves the legal up to you.) Setup is a snap, but the service costs \$4 a month.

The above are best suited for streaming simple playlists. Ambitious webcasters who want jingles, advertising or call-in segments should pick up a software package such as Pirate Radio (\$40; pirateradio.com) or SAM Broadcaster (\$200; spacialaudio.com). The dual-deck players with automated crossfade and the playlist-rotation features of SAM are the kind of technologies that real radio stations use to create professional shows. SAM also lets you compress your audio so that you can reach twice as many listeners on the same connection.



TO THE WORLD

If your broadcasting aspirations extend beyond your social circle, you'll need some way to share the burden of distributing your sound. That's

where Live365 (live365.com) comes in. For \$10 a month, you get a ready-made station with 100 megabytes of storage and a quota of 25 simultaneous listeners. Pay more (from \$15) and you can have 1,000-plus listeners and two gigabytes of space. Ironically, the basic service doesn't let you transmit live audio; you have to upload prerecorded material as MP3 files. Pony up \$15 a month, though, and you can hook up a microphone and audio player and start DJ'ing live and dangerously.

The free alternative to Live365 is a peer-to-peer app, which relays your audio along a chain of listeners to share the bandwidth load, allowing you to serve your sounds to a theoretically unlimited audience. Peer-cast (peer-cast.org) and IceCast (icecast.org) are the leading programs, but beware that both involve a fair amount of configuration and setup (find links to directions at popsci.com/h20). And remember, if one of your listeners' Internet connections goes bad, everyone down the line will suffer too.

Broadcast Tips >> **Keep it legal** If you're playing major-label artists, you should learn about licensing fees, lest Britney's lawyers come knocking. Live365 and Mercora include fees in their charges; otherwise, refer to copyright.gov/carp to see what you owe. Or avoid the issue altogether by playing music from unsigned artists with their permission. There are literally millions of tracks available on the Internet (start at redferret.net/pmwiki), and most artists are grateful for the exposure. **Stay small** Keep your audio files as small as possible. If you just want to beam out a late-night talk show, you don't need high-quality stereo, so convert it to mono and use a format like Ogg (vorbis.com). **Mic up** Nothing makes a broadcast sound more amateurish than crackly, hissy mic sound. Use a studio-quality broadcasting microphone such as the MXL 770 (\$90; zzounds.com). **Mac-cast** Got a Mac? Only Web-based tools Live365 and Shoutcast are compatible.

YOU 2.0

At the Intersection of Technology and the Body

Call me reactionary, but when insect repellent melts the fabric of my rain jacket, burns through my fishing line, and has the potential to cause seizures, well, that's not the bug juice for me. I don't care if the EPA still says DEET-based repellents are (mostly) safe—I'm



HERBAL ARMOR INSECT REPELLENT

\$5;
allterrainco.com
TECH: Natural bug juice
DOES IT WORK?
No bites yet

sticking to all-natural Herbal Armor, the only DEET-free skeeter guard I've found that works.

In my deep-woods trials it's kept away gnats, black-flies and all other biting vermin using nothing more potent than geranium, citronella and three other natural oils to mask your body's carbon dioxide emissions, which is what attracts the bugs. Compare that with DEET (N,N-diethyl-meta-toluamide), used by one third of the U.S. population every year: The EPA says you shouldn't wear DEET repellent under clothes, it warns to wash it off as soon as you can, and it will not allow labels to claim that DEET is safe for children. Oh, and Canada has outlawed concentrations higher than 30 percent.

Even if the occasional kamikaze bug slipped through a chink in Herbal Armor (though none did for me), I'd still prefer its nontoxic mix of lemon-grass, peppermint and herbs. —STEVE CASIMIRO



Find more resources and detailed instructions for DIY radio at popsci.com/h20.

Good advice is the best tool.

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ACE
The helpful place.

DEPT: **DIY**

INVESTIGATOR: **MIKE OUTMESGUINE**

TECH: Portable
Wi-Fi hotspot
COST: \$1,065
TIME: 4 hours

Be Your Own Hotspot

Turn a backpack into a portable, solar-powered Wi-Fi hotspot, and share a high-speed connection anywhere

PRACTICAL POPCORN

I love the fact that more and more devices are sporting built-in Wi-Fi—the Sony PSP, smartphones, even Kodak's EasyShare-One digital camera. The lone hitch: Wi-Fi is useless without a hotspot. Sure, thousands of spots are available, but few are free, and coverage is far from ubiquitous. What if you could marry the short-range power of Wi-Fi with the huge coverage areas of high-speed cellular services such as EV-DO to create a portable hotspot? You could use any Wi-Fi-enabled gadget anywhere you've got a cell signal. Play multiplayer games with friends in the park, or blog an event in real-time. Since EV-DO works at freeway speeds, you could even give Internet access to an entire road-trip caravan.

Those are exactly the kinds of things you can do with the backpack below. Its secret ingredient: the Junxion Box. Plug a cellular-network card into the book-size open-source-based device, and voilà—instant Wi-Fi hotspot, with speeds averaging around 700 kilobits per second. To power the box, I wired it to a 1.2-amp-hour battery and dropped both into the Voltaic Systems backpack, which has a built-in solar charger. Now I can surf for as long as three hours without being tethered to anything but a cell signal. The project isn't cheap, but prices for the components and service are sure to come down in the next year or so. In the meantime, you can find me in the hills around Southern California. I'll be the one surrounded by PSP-packing hikers.

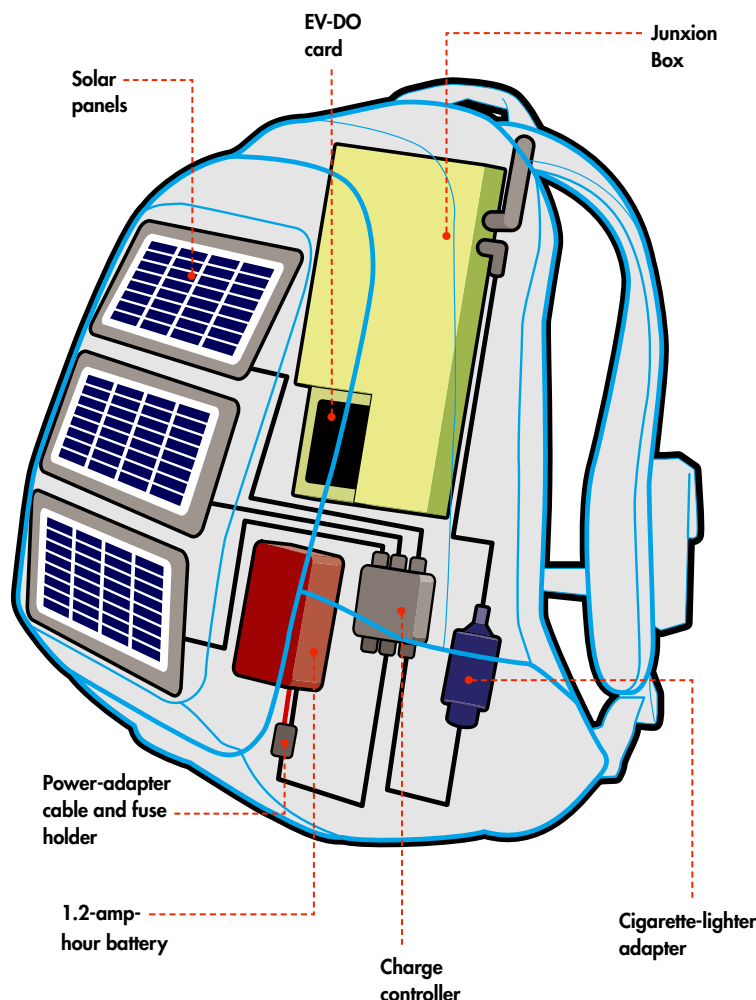


PARTS LIST

- Junxion Box wireless gateway \$700; junixionbox.com
- Verizon Wireless EV-DO PCMCIA card \$100; verizonwireless.com
- Voltaic Systems solar-charging backpack \$230; voltaicsystems.com

These parts are available at any electronics store:

- 12-volt battery with spade terminals, 1.2 or higher amp-hour \$15
- Male DC power plug, size M \$5
- 18-gauge wire, black and red \$5
- Female insulated quick-disconnect connectors, crimp-type, sized for battery spade terminals \$3
- In-line fuse holder \$7
- 20-amp fuse 50 cents



INSTRUCTIONS

- 1) Plug in your **EV-DO card** and set up the **Junxion Box** to automatically assign TCP/IP addresses using DHCP, and disable the authentication splash page.
- 2) To build the **power-adaptor cable**, cut a length of red wire and a length of black. Strip one end of each wire and crimp a spade terminal connector onto each. Strip the other end of the red wire, and solder it to one end of the **fuse holder**. Wrap the connection in electrical tape. Take apart the male DC power plug. Solder the end of the black wire to the negative terminal of the plug and the red wire to the positive. Wrap the exposed positive connection in electrical tape, and reassemble the power plug. Install a 20-amp fuse.
- 3) Connect the Junxion Box **cigarette-lighter adapter** to the backpack "power out" plug.
- 4) Connect the battery cable to the "battery" plug on the backpack's **charge controller**.
- 5) Take a hike!

POPSCI
ON THE WEB

See more photos of the Wi-Fi backpack at popski.com/h20.

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THE ONLY THING I HAD WAS THAT LITTLE SUREFIRE FLASH-
LIGHT...THE MOOSE STOPPED, LOOKED A TAD CONFUSED
AND TURNED AWAY FROM THE LIGHT. I WAS LITERALLY
INCHES AWAY FROM BEING TRAMPLED TO DEATH."

– **EVERETT MABRY, USMC**

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INVESTIGATOR: **THEODORE GRAY**

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ELEMENT: Titanium
PROJECT: Anodizing a titanium birdhouse
COST: \$75
TIME: 2 hours
DABBLER: ■■■■■ **MASTER**



The Guggenheim Bilbao museum in Spain is the largest titanium-clad building in the world, with 344,000 square feet of 16-thousandths-of-an-inch-thick pure titanium, designed by Frank Gehry. It's quite a pile, and I understand they also have art or something inside. To learn more about working with titanium sheeting, I set out to build a modern architectural wonder of my own: the Guggenheim East-Central Illinois Birdhouse.

Titanium justifies its high cost (I paid \$33 a square foot

LEFT: Anodizing a Guggenheim-inspired titanium birdhouse by running current through a patch of damp paper towel to a stencil.

at titanium.com) by its great strength, its weather resistance and its lovely colorful oxide layers. A transparent coating of oxide just a few wavelengths of light thick creates color on the surface through wave interference created when light reflected off the coating meets light reflected off the metal surface underneath.

Iron spontaneously forms an oxide layer—what we call rust—but it's not transparent. Aluminum forms a transparent layer, but it's too thick to make colors. Titanium is too chemically stable to form a coating spontaneously, which is partly why it's such a good metal for buildings, but you can force the coating artificially using nine-volt batteries, a paper towel and a solution containing phosphoric acid (I prefer Diet Pepsi, but any cola will do).

The idea is to run current through the soda and into the

MIKE WALKER; FACING PAGE, FROM LEFT: ERIKA EDE/GUGGENHEIM MUSEUM BIBAO, MIKE WALKER (2)



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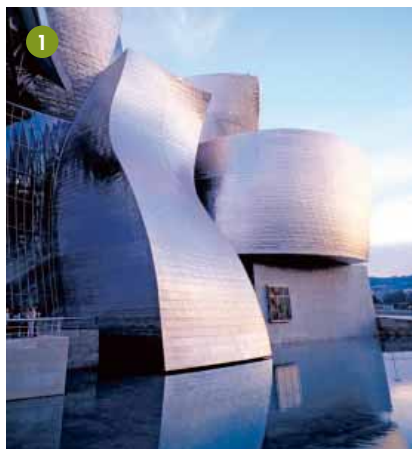




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1. What a budget 1.3 million times the size of mine will buy you.

2. It takes only a second to form the color, so freehand painting with a ball of tinfoil wrapped in a paper towel dipped in Diet Pepsi is quick and fun.

3. Even the texture of the paper towel can be seen in the pattern formed by this stencil.

to a deep blue. As you add more batteries, the colors cycle: A coating 3.5 wavelengths thick gives the same color as one 2.5 wavelengths thick, and so on. (Just be careful, because enough batteries combined can eventually produce voltages capable of delivering a painful or even deadly shock if you touched the wet towel.)

These colors are absolutely permanent. They are impervious to sunlight, acid rain, bird droppings, you name it. I wonder if the guards around the Guggenheim have instructions to keep a lookout for suspicious people carrying batteries and refreshing drinks. The possibilities for electro-graffiti on a titanium building that size are mind-expanding.

Read more about Gray's scientific pursuits at periodictable.com.

metal surface. Attach the batteries, then dip the titanium in a tub of cola to cover the whole surface, or use a pad or brush soaked in the soda of your choice and clipped to a battery

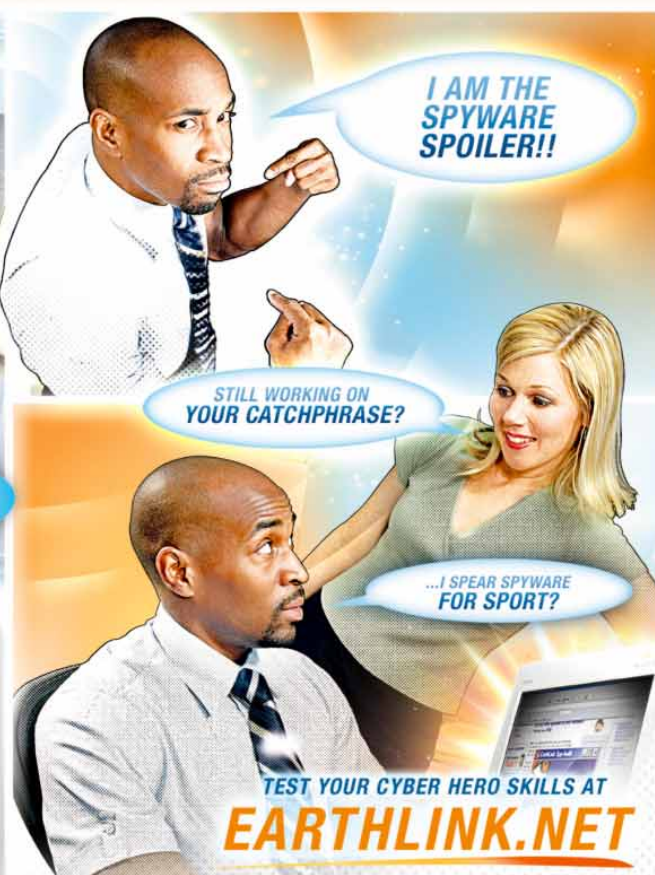
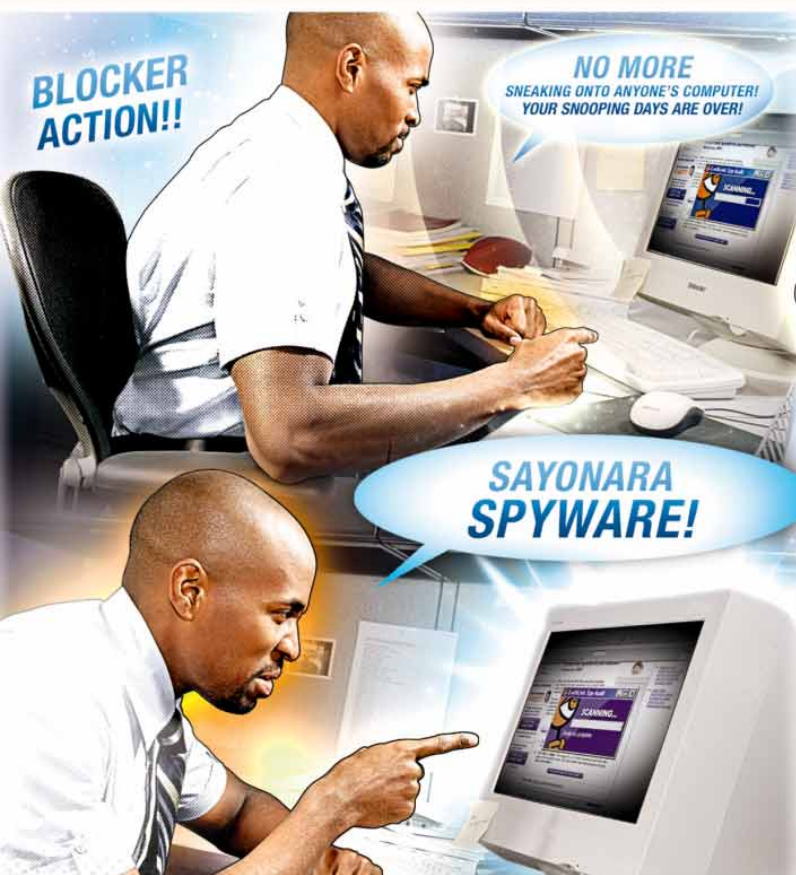
to "paint" or form patterns. You can even use tinfoil to distribute current through a paper towel placed over a stencil.

As current flows to the metal, an insulating layer of

oxide builds up, stopping when it is just thick enough to block the applied voltage. The thickness of the resulting layer is extremely consistent, within a small fraction of a wavelength of light. Higher voltage forces it to grow a thicker coating and thus creates a different color. One nine-volt battery gives a pale yellow, two gives light blue, three gets you

Ti
Titanium
22

MELTING POINT: 3,034° F
DISCOVERED BY: William Gregor in 1791
COMMON USES: Golf clubs, bicycles, fireworks
NAMED AFTER: The Titans, 12 elder gods overthrown by Zeus and replaced by the Olympians



TECH SUPPORT

HEY, READERS: Contribute to this page by sending your favorite tips, gear suggestions, and questions for the Geek Chorus to h20@time4.com.

ASK A GEEK | MERLIN MANN



Q: What is tagging?

A: Tagging is the act of assigning your own keywords to things online—photos, blog entries, bookmarks—so that you can easily categorize, locate, and share them in the future. One of the best examples is del.icio.us, which lets you save Web bookmarks to a page on the site instead of to a file stashed away on your computer. This way, you can access them from anywhere and let other people see what sites you like. So if you saved popsci.com to your collection and tagged it with “science, tech, magazine,” anyone who clicked on the “science” tag would see it, along with any sites anyone else had tagged “science.” There are no rules for coming up with tags, so results can be unpredictable, but that’s part of the fun, and most are pretty intuitive anyway.

Tagging is also a great way to find stuff related to topics that interest you. Missing life in the Bay Area? Go to the photo-sharing site flickr.com, and click on “San Francisco” to bring up hundreds of photos of the city.

Some sites, including del.icio.us, flickr.com, and the goal-sharing site 43things.com, also generate RSS feeds for specific tags, so you can easily follow certain topics, such as “recipes,” “mac” or “webdesign.” You can even subscribe to friends’ lists to see what they’re surfing, or you can generate custom feeds for them—tag certain items “for Madeline,” and she can check out all the sites that you’ve bookmarked just for her.

MERLIN MANN is a San Francisco-based freelance writer and consultant. He is the creator and editor of 5ives.com and the popular productivity-tips site 43folders.com. He’s currently co-writing the book *Life Hacks* for O’Reilly.

YOUR GEAR

Lighten your cable load on your next international jaunt with the Travel Plug Adapter (\$20; kensington.com). In addition to its multiple slide-out plugs that work in 150 countries, it has a pop-on USB interface that can deliver the juice to any USB-powered device, including an iPod. It also sports a built-in replaceable fuse to protect against power surges.

—Suzanne Kantra Kirschner, *PopSci* senior technology editor



THE TIP SHEET

□ MAKE SHORTER URLS

<http://www.amazon.com/exec/obidos/tg/browse/-/468646/102-4052644-7759301>. That’s the Web address for Amazon.com’s page of free music downloads—a little unwieldy for sending in an e-mail. [Doiop.com](http://doiop.com) lets you input URLs like that one and create a shorter version using an extension you specify, such as doiop.com/amazonfreemusic, which goes to the same page and never expires. —H2.0 staff

□ ORGANIZE YOUR LIFE ONLINE

Backpack is a new Web-based application that allows you to keep track of to-do lists, set reminders, write notes, and store images and files on Web pages that you create with its simple interface. Then you can access them from any computer with an Internet connection. Try it free at backpackit.com. —H2.0 staff

THIS IS BROKEN

I REALLY HOPE THERE’S A “K” AFTER THAT ELLIPSIS

From	Subject
Agift	Gift card from Homedepot
Circuit City	Holiday savings start today -- take a pee...
Sophos Alert System	Sophos Anti-Virus IDE alert: W32/Delf-IV

See more examples of things broken at thisisbroken.com.

The President's Advisory Panel on Federal Tax Reform (www.TaxReformPanel.com) is searching for new tax reform ideas. During a public hearing in Washington, D.C., no new ideas were presented, only old standbys: "Flat Tax", "Fair Tax", "National Sales Tax". I flew to Washington as well to present my brand new no-accounting, no-tax filing, no-audit system that will certainly become the new tax system

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for some countries around the globe. So why not be first with it in the USA? But it sounded too good to be true for the "experts" on the panel and was not selected for presentation. www.TheTroubleWithExperts.com is that they are the guardians of the status-quo. Help me help you to a brilliantly simple new tax system. I cannot do it alone. I need your help. **Get involved.** Help replace our insane 17,000 page tax code.

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match the user's ability to perform work. It balances blood sugar, and repairs bad backs and shoulders. Too good to be true? Get our free video and see for yourself. The best proof for us is that 97% of rentals become sales. Please visit our website at: www.FastExercise.com.

The typical ROM purchaser goes through several stages:

1. Total disbelief that the ROM can do all this in only 4 minutes.
2. Rhetorical (and sometimes hostile) questioning and ridicule.
3. Reading the ROM literature and reluctantly understanding it.
4. Taking a leap of faith and renting a ROM for 30 days.
5. Being highly impressed by the results and purchasing a ROM.
6. Becoming a ROM enthusiast and trying to persuade friends.
7. Being ignored and ridiculed by the friends who think you've lost your mind.
8. After a year of using the ROM your friends admiring your good shape.
9. You telling them (again) that you only exercise those 4 minutes per day.
10. Those friends reluctantly renting the ROM for a 30 day trial. Then the above cycle repeats from point 5 on down.

The more we tell people about the ROM the less they believe it.

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FYI

FACTS, ANSWERS, ODDITIES & ENTERTAINMENTS FOR A MONTH OF SCIENCE



WHERE'S THE BEEF?
Activists protest Eddie Bauer's stain-proof Teflon clothing. Thing is, there's no Teflon in the fabric.

[NANO WOES]

Protesting High-Tech Trousers

A GROUP OF NEAR-NAKED PROTESTERS demonstrated in front of Chicago's flagship Eddie Bauer store on a chilly Saturday afternoon this May. The target of their ire was not high prices or sweatshop labor but rather a new and, in their opinion, terribly insidious force invading clothing stores across the country: nanotechnology.

Specifically, the members of the group THONG (that's Topless Humans Organized for Natural Genetics) were very upset about Eddie Bauer's Nano-Tex line of shirts and khakis, which employ a water- and stain-resistant material made by the Nano-Tex company in Emeryville, California. You're probably familiar with Nano-Tex's products. Its fabric is also used in clothing sold in stores as varied as Nordstrom, Old Navy and the Bass Pro Shops. The pitch of Nano-Tex is simple: Using nano-

technology, the makers have engineered cheap, comfortable, ketchup- and red-wine-thwarting fiber.

But this widespread use and casual acceptance of novel technology is exactly the problem, according to the members of THONG. In a statement posted on the blog *NanoBot*, THONG member Kiki Walters says:

We're out here naked so people can SEE THE PROBLEM, nanotech is such a radical and unpredictable new technology, like biotech, that it takes something highly visible, like a naked body, to get people to focus on the need to stop corporations from using humans as guinea pigs for new, untested, and unstable new technologies!

Let's set aside the question of whether THONG's basic argument has merit. More interesting is whether the argument applies in this case at all—

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whether Eddie Bauer is guilty of shilling nanotech-laced laundry.

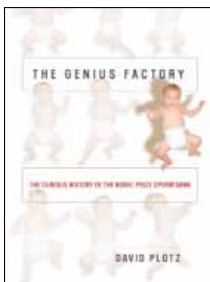
Nanotechnology is generally considered to be the manipulation of materials on an atomic or molecular scale, especially to build tiny devices. Build a miniature robot out of individual silicon atoms, and that's clearly nanotechnology. But the Nano-Tex pants at issue work because the fibers have been treated with chemicals, called hydrophobic monomers, that repel water. The treatment is inarguably an advance over decades-old Teflon-based laminated coatings (and Nano-Tex has 17 patents to prove it), but skeptical folks might just call this chemistry, not nanotechnology.

We're not going to lament here the loss of the precise meaning of the word "nanotechnology" to savvy marketing. Instead we offer unsolicited advice to reflexive opponents of new technology: There are many recent technological advancements whose applications demand careful consideration and thoughtful debate. Before you strip

down to your skivvies in earnest protest, please, try to make sure that the thing you're protesting has something to do with the thing you're protesting.—MICHAEL MOYER

[BOOK REVIEW]

Breeding a Better Baby, Maybe



THE GENIUS FACTORY:
The Curious History of the Nobel Prize Sperm Bank

by David Plotz;
Random House;
288 pages;
\$24.95

TWENTY-FIVE YEARS AGO, A RETIRED optometrist named Robert Graham set out to save the planet. As the inventor of unbreakable plastic eyeglass lenses,

he certainly had the cash to do great good as a traditional philanthropist, building libraries, say, or endowing scholarships for disadvantaged youth. Instead the Southern California eccentric changed the world in a more unusual way. He used his millions to found the Nobel Prize Sperm Bank.

Graham intended for the bank, officially called the Repository for Germinal Choice, to contain sperm donated exclusively by Nobel Prize winners. It was troubled from the start. Some speculated that it was a eugenic plot, but most simply dismissed it as a bad joke. As *Slate.com* deputy editor David Plotz deftly shows in his entertaining account of the bank, *The Genius Factory*, both opinions hold some validity, yet neither captures the deeper significance of what he calls "the most radical experiment in human genetic engineering in American history."

In the end, few laureates were willing to donate their germline to the bank. ("The old-fashioned way is still best," said Linus Pauling, winner of the 1954

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Max Stührling's big mistake

When quality isn't enough to take on the big guys.

The fine horologists (watchmakers) at Stührling just built a super luxury watch for this Christmas. Using one of the most complex regulator movements ever designed, they engineered the Regulator Series 3. With its large separate minute dial and small hour dial, this watch was built to take on the likes of Rolex™ and Patek Philippe™ and was to retail for \$5,750. Well, Max made a mistake. The other luxury watch manufacturers had locked up the shelf space at the high end jewelers by offering large advertising contracts, so Max is left with 3,435 of these magnificent "Regulator Series 3" watches.

Max needs to liquidate these luxury watches so

he came to us at NextTen. You see, NextTen has become synonymous with high quality watches at extraordinary values. We are offering the Regulator for a miraculous price—\$349.⁷⁵. Max is in tears, but he needs the cash. When the 3,435 watches are sold, that will be the end of them. I am keeping three for myself since I'm convinced that the rare design will make this watch sought after by collectors in years to come.



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make you stare at this unique watch. The dial is machined in a silver-white star burst and the escapement is visible through the dial so you can watch the balance wheel in action. The movement oscillates at 21,600 vibrations per hour for accuracy to within seconds per day. The tonneau styled case is fused in 23k gold and the alligator-embossed band is fitted with the finest butterfly clasp that we have seen in our travels. If you desire the best, the unique and the rare, the Stührling Regulator is built for you. We do expect to be out of this watch in just a few weeks, so please act quickly.

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Chemistry prize and the 1962 Peace prize, when solicited.) Most of the sperm came from professors in science and engineering who, though undoubtedly intelligent, were not Nobel-caliber. The only genius to donate publicly was the unsavory—at least as far as eugenics controversies were concerned—William Shockley.

Shockley represented the best and worst in human rationality: His invention of the transistor launched the age of the computer, but his desire to improve the net wisdom of civilization by eliminating those with low IQs led him to claim that there might have been “good things about Hitler.” Graham, Plotz argues, didn’t share Shockley’s extremism. He limited his vision to so-called “positive eugenics,” remarking the human species by breeding rather than weeding. Graham hoped that, within a couple generations, the dim-witted populace would be genetically replaced with a smarter one. People would become more rational and more adept at such practical enterprises

as engineering and business. In other words, people would become, in theory, more like Graham.

In 19 years, before the bank shut down (Graham died two years prior to its closure), 215 bank-spawned children were born, and, until Plotz set about finding them as research for this book, the identities of all but two were unknown. Unsurprisingly, as Plotz discovered, they weren’t intellectual clones of Shockley or Graham. Although many of the 30 he interviewed were bright, there was nothing superhuman about them. Moreover, as one of the smartest was shrewd enough to see, “the fact that I have a huge IQ does not make me a person who is good or happy.”

These people, Plotz observes, are “messengers from our future,” when considerably more top-down genetic control will be exerted by parents seeking to breed extraordinary children. Looking at Graham’s ill-fated experiment, we can see how poorly we sometimes anticipate our descendants’ needs.

—JONATHON KEATS

[SHORTY SCIENCE]

Next-Gen Toy Makers

IMAGINE JOINING THE PANTHEON OF Hasbro action figures. There on the mantelpiece: G.I. Joe, Boba Fett, Buzz Lightyear and you—well, a 12-year-old you, in braces, beat-up sneakers, and jeans that are three sizes too large. The chance to have a personal action figure made to order, or to win a week at space camp, served as a powerful lure for the 1,522 kids who participated in the third annual TOYchallenge.

The rules of the contest are simple: Design a toy you’d like to use, then build it. Participants must be in the fifth through eighth grades, and at least half of the team must be girls. Teams can’t spend more than \$200 on parts. Oh, and no help from grown-ups. “The coaches are just there to stop the kids from poking their eyes out,” says Kristen Greenaway, TOYchallenge’s director.

Among this year’s entries were dominoes that can be arranged to play vari-

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CORDLESS JUMP ROPE
Sisters Chrissy, Kelly and Karen Redmond demonstrate their jump-the-infrared-beam game "Hop to It," a finalist in the TOYchallenge.

11- to 13-year-olds developed a high-tech version of the swimming-pool game Marco Polo that was anointed one of four contest finalists. "They have learned about Ohm's law and how to draw an electronic circuit diagram."

As this issue went to press, two winning teams were to be chosen on June 27 at Hasbro headquarters in Rhode Island. For more information and to find out who won, go to toychallenge.com.—EMILY LABER-WARREN

[NERDULAR NEWS FLASH]

Something Fishy Going On

FROM WASHINGTON UNIVERSITY: "Fish Genitalia May Balance Attractiveness with Predatory Escape."

The scientists found that female mosquitofish prefer the well-endowed male. Unfortunately for the males, larger genitalia impede a speedy getaway, making them more likely to be eaten by predators. Sometimes, you just can't win. ■

COURTESY PAT REDMOND

ous tunes as they fall, and a remotely controlled amphibious vehicle that drives on land and floats or sinks on command. Last year the contest yielded a Twister-like memory game called "Wet Your Pants" that spritzes players with water when they blunder. But

aside from getting kids to think about toys, it also introduces them to the panoply of items that they'll probably see in their university science courses. "The kids have made multiple circuit boards," says Janice Hansen of Irvine, California, a coach whose team of eight

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(CONTINUED FROM PAGE 67)

bananas, Swennen says, 20 million people would face “massive destabilization.”

The reason bananas are so susceptible to disease has to do with their ancient origins. Almost no plant has been cultivated longer by humans. The earliest banana production began in Southeast Asia, but of the hundreds of varieties found in that region, only about 10 or 15, according to Swennen, were brought to Africa. (Bananas are a perfect crop for subsistence farming, since once a family has a healthy plant, no more seeds need to be planted—or bought; instead farmers simply replant shoots, called “suckers,” from existing trees.) Bananas mutate easily, and of the few Asian banana varieties that originally made it to Africa, more than 200 new varieties have emerged. But these varieties remain genetically similar, so they’re prone to parallel afflictions. The situation in Latin America is even worse. “Only a few moved from Africa to there,” Swennen says, “so you’ve got even lower variability.”

The geneticist has already created one sweet banana that, using genetic material from radishes, has built-in resistance to Black Sigatoka. The lab is

also developing high-yield plantains for Africa and a banana manipulated to be high in beta-carotene. Swennen emphasizes that biotech is literally the *only* way to save the Cavendish, which, because it is 100 percent seedless, can’t be improved on by traditional hybridization methods. And FHIA’s approach of growing a new variety from scratch, he argues, is too slow.

Traditional banana scientists, like the ones in Honduras, know that the methods they use are slower by decades than the lab-induced DNA manipulation that Swennen and his fellow researchers are working on. But they also know that resistance to genetically engineered foods runs deep among the world’s consuming public. A recent survey by Fyffes (the banana importer that is to Britain what Chiquita is to the U.S.) found that 82 percent of U.K. shoppers said they would never buy a genetically altered banana, even if proven to be safe, even if doing so allowed the elimination of pesticides and other potentially harmful agricultural chemicals—a major advantage, supporters say, of biotech crops. Public aversion to DNA-altered foods exists throughout Europe, where most such fruits and vegetables are banned.

Although Chiquita wouldn’t comment for this story, company executives have repeatedly rejected biotech techniques for use in consumer products.

“I can’t understand this romantic idea that nature is perfect, and that what we do is create Frankensteins,” Swennen says. People “are frightened—and they’re wrong.” He believes that the threats bananas face mean that they are likely to be the bioengineered food that finally forces global shoppers to consider—and accept—science’s inevitable intervention in the agricultural process. “There’s almost no choice,” he says. “We need resistant bananas.”

The sprawling old compound in Honduras

still houses a small set of Chiquita offices, but the company’s presence in the region is better symbolized by the oversize, fading logo—a blown-up version of the sticker you find on your grocery-store fruit—painted on the side of the company’s now run-down country club. Chiquita and Dole still farm thousands of acres here, but they’re more absentee landlords than the all-powerful entities they once were. When I had dinner at the club, Leonel Castillo told me that the dining room we were sitting in was “the place where governments were once made—and broken.” That controversial legacy, which led to the coining of the term “banana republic,” is one of the reasons the major banana companies are generally unforthcoming with the media. Chiquita does nod to the old days on its Web site, where a chronology page called “Our Complex History” acknowledges, alongside more positive achievements, dubious acts: the company’s participation in the 1954 overthrow of Guatemalan president Jacobo Arbenz Guzmán; the 1961 use of its corporate steamship fleet to support the failed Cuban Bay of Pigs invasion; antitrust lawsuits; the suicide of United Fruit chairman Eli Black (he jumped from the 42nd story of New York’s Pan Am building) after a 1975 bribery scandal. Banana companies remain the focus of environmental and labor activism, although both Chiquita and Dole have worked in recent years to have their operations certified by groups such as the Rainforest Alliance.

There’s no doubt that workers at banana plantations are better treated than they were in the 1950s, when Honduran author Ramón Amaya Amador published an allegorical novel called

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Green Prison, but some critics say the industry has a long way to go. The biggest problem, says Alistair Smith, coordinator of BananaLink, a British activist organization, is the continued use of pesticides, which have huge "negative human and environmental impact." His group cites instance after instance of long-term ill health effects in workers.

The pesticide issue is a big one for banana researchers as well. It isn't so much for banana consumers, at least directly, since most of the substances used on the plants don't make it into the flesh of the thick-skinned fruit. But the human and monetary cost of spraying grows higher as more chemicals are needed to battle increasingly virulent diseases. "In the 1970s we controlled Black Sigatoka by spraying 10 to 12 times a year," says FHIA director Adolfo Martínez, an agricultural economist. That frequency has jumped to almost weekly, at a cost of up to \$1,000 per acre for every spraying. "There will come a point at which that is neither environmentally nor economically sustainable," Martínez says. Despite concerns over pesticides, the position of the fruit companies has been to combat disease with chemicals. David McLaughlin, Chiquita's senior director for environmental affairs, told the *Boston Globe* in 2003 that programs like FHIA's "cost us a lot of money for very little result. We concentrate on research into fungicides now."

The increasing possibility of problems with the Cavendish has led to a change in that position. During a 2004 conference call with shareholders, Chiquita president Fernando Aguirre said that FHIA would be "providing Chiquita with an R&D department that is working on several varieties of bananas with different sizes and tastes. They are also working on better resistance to plant diseases."

How much time is left for the Cavendish? Some scientists say five years; some say 10. Others hold out hope that it will be much longer. Aguilar has his own particular worst-case scenario, his own nightmare. "What happens," he says, with a very intent look, "is that Panama disease comes before we have a good replacement. What happens then," he says, nearly shuddering in the shade of a towering banana plant, "is that people change. To apples." ■

Dan Koeppel's last article for POPULAR SCIENCE was about the science of bird songs.

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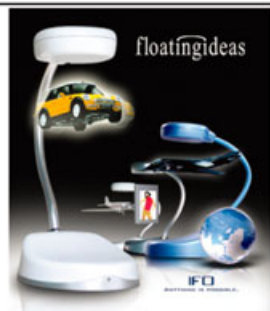
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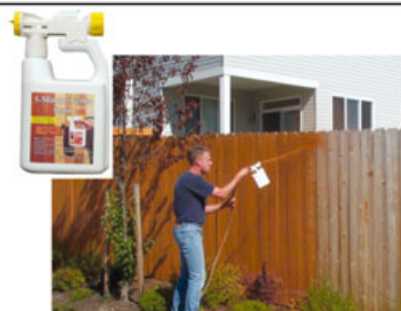
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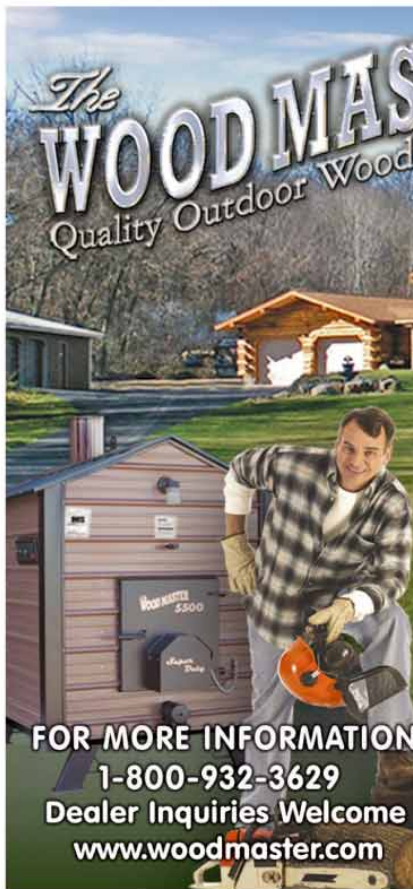
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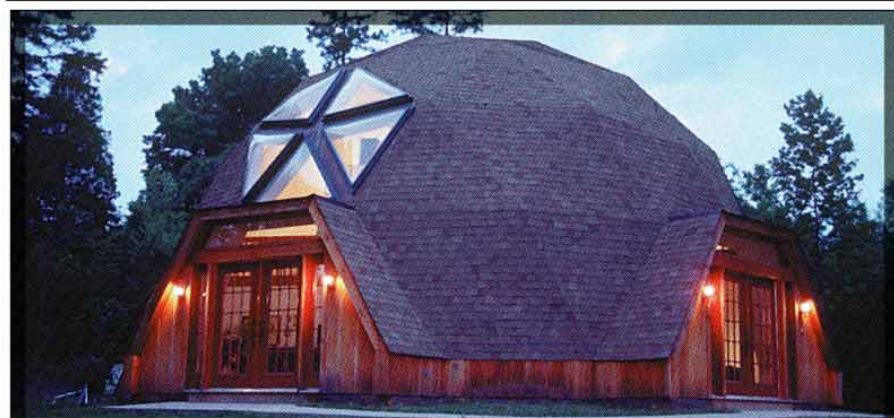
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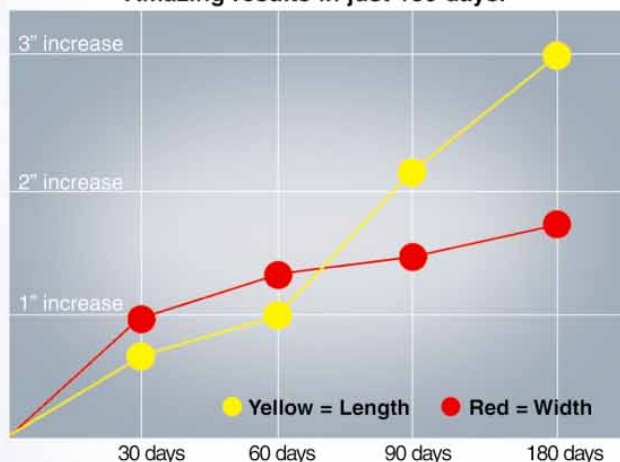
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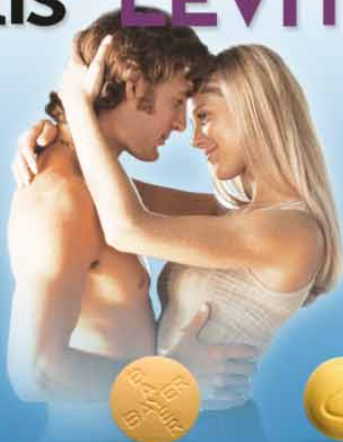
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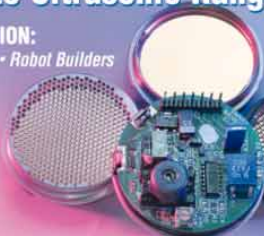
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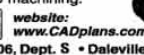
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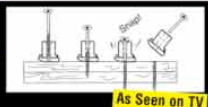


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FROM THE POPULAR SCIENCE ARCHIVES

JUNE 1949

No Longer Sub-Standard

Combining new battery and engine technology, a deep-sea espionage submarine makes its Cold War debut

"Now we are getting nearer to true submarines," PopSci proclaimed in June 1949 of the Navy's newly revamped U.S.S. *Tusk*, "not just buttoned-up surface ships that can dunk for a few hours." The *Tusk*, first commissioned as a torpedo boat in 1946, reemerged as a deadly spy sub capable of remaining in the deep for weeks, thanks to a snorkel that allowed its diesel engines to run underwater while its upgraded batteries recharged. This technology and a sleek aircraft-inspired design improved the sub's speed from 10 knots to 15 knots. For the next two decades, the *Tusk* patrolled the Mediterranean Sea, eavesdropping on Eastern Bloc communications. Today the 60-year-old vessel still operates as a training ship, a living ancestor of the new generation of spy subs equipped with docks for unmanned submersibles and (nearly) silent propulsion [see "Exposing the Spy Sub of the Future," page 81]. —MATTHEW OLSON



OTHER NEWS FROM THE JUNE 1949 ISSUE



WARPLANE SCRAP TURNED THREE-WHEELER

The fuel tank of a retired World War II fighter plane served as the body of this unique three-wheeled "motorcycle," which zipped along at 45 mph and could roam up to 114 miles on two gallons of gas. Surprisingly, you can still build your own—kits sell today for \$1,000 (hotrodssuperstore.com/p38beltanfib.html).

MILK: IT DOES THE RESEARCH GOOD

By milking some 10,000 mice over a 12-year period, researchers isolated the virus that causes breast cancer in the rodents. Recent research now suggests that a similar virus may be linked to most breast cancers in humans.

MACHINE TRUMPS UMP

"There would be no arguing with the umpire with this foul ball indicator," we wrote. When a baseball struck rods hanging on either side of the foul pole, a light flashed green for fair or red for foul. The invention quickly struck out: It blocked the crowd's view of the field.

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